Federal Republic of Nigeria

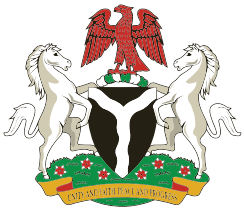
Federal Ministry of Agriculture
and Rural Development (FMARD)

Strategic Food Reserve in Nigeria

An Assessment of Optimal Stock Levels and Storage Capacity

AGRA
Sustainably Growing
Africa's Food Systems

HUB FOR AGRICULTURAL POLICY ACTION (HAPA)



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March 2023

Strategic Food Reserve in Nigeria – An Assessment of Optimal Stock Levels and Storage Capacity, March 2023

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The Ministry of Agriculture acknowledges the following funding and technical partner:

ABOUT AGRA

AGRA is an African-led non-profit organization formed in 2006 in response to the call by former UN Secretary-General Kofi Annan for a uniquely African green revolution. AGRA's vision is to transform agriculture from a solitary struggle to survive into farming as a business that thrives, putting farmers at the center of the continent's growing economy. AGRA recognizes that developing smallholder agriculture into a productive, efficient, and sustainable system is essential to ensure food security, lifting millions out of poverty and driving equitable growth across the continent. AGRA's mission, therefore, is to catalyse and sustain an agricultural transformation in Africa through innovation-driven productivity increases and access to markets and finance that improve the livelihoods of smallholder farmers. AGRA achieves this mission with and through partners.

About HAPA

Across African countries today, there is a need for better, more timely use of evidence, and more targeted approaches, to improve the quality of policymaking by governments. The Hub for Agriculture Policy Action (HAPA), is a Unit within AGRA that provides policy advisory services to governments seeking to reform, refine, and/ or develop a more clearly defined policy direction. The approach recognizes the urgent need for timely policy support to the agriculture sector, which plays an important role in ensuring inclusive growth. It also recognizes the demands for political expediency and the need to ensure that a particular policy direction is anchored in evidence.

Through Consolidation and Translation (C&T) of evidence, HAPA's work entails collating existing evidence, expertise and best practice that are relevant to a government request for policy support and processing these into a set of rationalized and costed policy options. HAPA works with local partners such as research actors to collate existing data and evidence, expertise, and best practices that respond to a government request for policy support and package these into a set of actionable policy recommendations.

Acknowledgement

We acknowledge the following people and institutions for their support: The Food & Strategic Reserve Department (FSRD): Dr. Haruna Sule, Dr. Callistus Okolo, Engr. Francis Adole; The Hub for Agricultural Policy Action (HAPA), AGRA: Dr Paul Thangata, Dr. Kehinde Makinde, Dr. Thomas Arokoyo, Dr Davis Muthini, Dr Abdoulaye Djido, Sibusiso Nhlengethwa; AgricBusiness and E-Commerce Nig Ltd: Alebode Isedu, Olatunji Amos Dada, Alhaji Musibau Olumuyiwa Azeez, Engr. Moses Oyewale Adewoye.

Comments

Comments, suggestions as well as requests for clarification of information contained in this report are welcome and should be addressed to: AGRAHAPA@agra.org

Table of Contents

List of Tables

List of Figures

List of Annexes

List of Acronyms

AB&EC	Agribusiness & E-Commerce Nigeria Limited
ACOMEX	Agricultural Commodity Exchange Market
ACPM	Agricultural Commodity Storage, Processing and Marketing
ADF	Agricultural Development Fund
AFEX	African Exchange Holdings
AGRA	Alliance for a Green Revolution in Africa
APP	Agricultural Promotion Policy
ARCN	Agricultural Research Council of Nigeria
ASE	Abuja Stock Exchange
BLR	Buyer of Last Resort
CAADP	Comprehensive African Agricultural Development Programme
CH	Cadre Harmonise
COMEX	Commodity and Futures Exchange Market
CSR	Civil Service Regulation
ECOWAP	Economic Committee of West African Africa Agricultural Policy
ECOWAS	Economic Community of West African States
EFSRA	Emergency Food and Security Reserve Administration
EGTE	Ethiopian Grain Trade Enterprise
e-NWR	Electronic Negotiable Warehouse Receipt
EOP	Economics of Production
FAO	Food and Agriculture Organization
FAOSTATS	FAO Statistics
FCI	Food Corporation of India
FCT	Federal Capital Territory
FEC	Federal Executive Council
FEWS NET	Famine Early Warning System Network
FGN	Federal Government of Nigeria
FMARD	Federal Ministry of Agriculture and Rural Development
FMN	Flour Mills of Nigeria
FSRD	Food and Strategic Reserve Department
GDP	Gross Domestic Product

GMP	Guaranteed Minimum Price
HMA	Honourable Minister of Agriculture
IDPs	Internally Displaced Persons
IPCP	Phase Classification
LBA	Licensed Buying Agents
LSMS	Living Standard Measurement Survey
MARKETS	Maximizing Agricultural Revenue in Key Enterprises
MDAs	Ministries, Departments and Agencies
MT	Metric Tonnes
NABG	Nigeria Agricultural Business Group
NADF	National Agricultural Development Fund
NADMIS	National Agriculture Data Management and Information System
NAERLS	National Agricultural Extension and Research Liaison Services
NAFDAC	National Agency for Food and Drug Administration and Control
NAFSS	National Agriculture and Food Security Strategy
NATIP	National Agriculture Technology and Innovative Plan
NBS	National Bureau of Statistic
NCX	Nigeria Commodity Exchange
NEMA	National Emergency Management Agency
NFRA	National Food Reserve Agency
NFSR	National Food Security Reserve
NIPRD	National Institute for Pharmaceutical Research and Development
NWR	Negotiable Warehouse Receipt
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
P&PC	Planning and Policy Coordination
PPP	Public Private Partnership
RFRA	Regional Food Reserve Agency
SAP	Structural Adjustment Programme
SFRA	Strategic Food Reserve Agency
SGR	Strategic Grains Reserve
UN	United Nations
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WDRA	Warehouse Development Regulatory Authority
WFP	World Food Programme
WRS	Warehouse Receipt System

Foreword

I am pleased to note the progress that our country, Nigeria, has made in its drive to enhance food security through the storage of quality food items for rainy days. Nigeria embarked on the construction of her first set of high-capacity metallic Silo Complexes for her National Strategic Food Reserve system in 1987. Since then, the country continued to build capacity in that direction and currently has a total of 33 Silo Complexes with a total holding capacity of 1,336,000 Metric Tonnes (MT) for assorted food commodities. In 2019, 17 silos were successfully concession to the private sector.

There is a need for a sound and efficient Strategic Food Reserve system in Nigeria that cannot be overemphasized. Currently, Nigeria the 7th most populous country in the world, with a population of over 210 million people (projected to hit over 370 million by the year 2050); is prone to the prevailing realities of climate change, pervasive insecurity, ongoing distortions to the world's socio-economic order and problematic food production systems caused by COVID-19 pandemic and the war in Ukraine.

The outcome of the study contained in this report provides a policy direction for restructuring the National Food Strategic Reserve system for optimal performance, in line with global best practices in food reserve systems. The findings will therefore be a worthy must-read for individuals and entities, especially in the strategic reserve subsector that would be interested in enterprise restructuring for global realignment in the ever-changing service and performance landscape and increasing competitiveness in the agricultural ecosystem; it will be a good reference material. I, therefore, highly commend the work and recommend this report to the public.

The FGN is most grateful to AGRA for this support. I assure you that my Ministry (FMARD) will work assiduously to streamline the findings and, as much as possible, endeavour to adopt the recommendations for a better and more focused National Strategic Food Reserve delivery system for the greater good of the people of Nigeria. I am also looking forward to the continuation of the partnership and to further capacity-building engagements and exposure of the department to further strategic food storage reserve value chain developments around the globe to further strengthen our national food security reserve strategies.

Lastly, I thank the Ministry of Agriculture and Livestock Development of the Republic of Kenya for hosting the member of FMARD as part of this study to learn from their Kenyan counterparts. These lesson-learning interactions are important to both countries to learn and adopt best practices from each other.

Dr Mahmood Muhammad Abubakar
Honourable Minister of Agriculture
and Rural Development

Acknowledgement

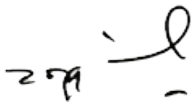
It gives me pleasure and honour to recall and note that the technical support partnership to our Ministry i.e. the Federal Ministry of Agriculture and Rural Development (FMARD), by AGRA in the area of policy alignment to strengthen the operations and management of the nation's Strategic Food Reserve System, which started in Nairobi, Kenya at the onset of COVID-19 Pandemic in 2020, has advanced to the completion of the first phase of the technical support. This is evidenced by the successful completion of an in-depth Study of the operations and management of the nation's Strategic Food Reserve System, and the production of the validated outcome by AGRA for a better and more efficient Food and Strategic Reserve delivery system for the nation. The Study centred on three (3) key areas which comprised.

- Support to determine optimal stock levels for the FSRD.
- Assessment of the existing storage infrastructure capacity; and,
- Designing and developing partnership models with the private sector.

AGRA's policy support to the Ministry has been most wonderful and I would like to express my deepest gratitude for a tireless and enduring relationship, and for identifying the gaps in the Strategic Food Reserve subsector and carrying out the support partnership Study in that area. Unarguably, the policy development support journey to the Ministry benefitted from strong backing provided by the development partners, notably the Food and Agriculture Organization (FAO), the World Food Programme (WFP), Bill and Melinda Gates Foundation (BMGF) and a host of other governmental and non-governmental organizations across the globe. To all those bodies and those in the background, we are most grateful.

My appreciation also goes out to the Consultant, AgricBusiness and E-Commerce Ltd who carried out the Study on behalf of AGRA, the staff of the Ministry, particularly the staff of the Food and Strategic Reserve Department for cooperation and commitment to ensuring the timely delivery of the Technical Support initiative, and to all Ministries, Departments, Agencies, organizations and individuals who spared time and resources to painstakingly carry out the validation of the Study Report.

I commit to facilitating the implementation of the recommendations in the Study Report to give a fresh impetus to delivering the objectives of the nation's Strategic Food Reserve System in the overall dream of a better and more food-secure Nigeria in tune with emerging global standards in the subsector.



Dr Ernest A. Umakhihe
Permanent Secretary
Federal Ministry of Agriculture and Rural Development

Preface

The combined impact of climate change, the runaway inflation induced by the COVID-19 pandemic, and the trade disruptions resulting from the Russia-Ukraine crisis have upset food systems and affected the food security of millions of people across the globe. Low-income and developing nations in Africa are the most affected due to the fragility of their food systems. Further, many African countries are faced with high debt levels that narrow the fiscal space and make temporary subsidies on fuel, fertilizers, and food products untenable. This is disrupting economic recovery efforts from the impacts of COVID-19. Given the challenges, Africa should adopt a continental approach to food security by accelerating regional initiatives such as trade, regional food balance sheets and regional frameworks for food reserves.

AGRA is working with African governments and institutions to catalyse an agricultural transformation in Africa improving yields using innovation and technology and improving access to markets and finance that improve the livelihoods of smallholder farmers. AGRA is also working with governments to reform agricultural policies that create a business-friendly environment for farmers and investors alike. The Hub for Agricultural Policy Action (HAPA) is an initiative of AGRA that supports governments in generating and consolidating evidence to inform policy. This model is critical to ensuring that policy making is based on data and evidence and not political expediency.

This report is the product of the partnership between The Federal Ministry of Agriculture and Rural Development (FMARD) through the Food and Strategic Reserve Department (FSRD) and AGRA's HAPA initiative. The partnership has seen HAPA support the Ministry through a study to determine the optimal stocks for strategic food reserves against Nigeria's current needs for emergencies and price stabilization, and identifying the key policy, storage, and management bottlenecks towards improved efficiency, responsiveness, and economic sustainability of the country's Strategic Grain Reserve. The report outlines mechanisms through which Nigeria can operationalize an efficient and responsive National Food Reserve to respond adequately to food supply and food price disruptions in the country.

It is my hope that this work will not only benefit Nigeria but inform other African governments of ways of improving the efficiency of SGRs and utilizing it as a tool for risk management against price volatility. More importantly, governments should make sure that the SGR provides a market for smallholder producers. Further, in some countries, the SGR can equally support social safety net initiatives such as school feeding programs. The decisions and context of how the SGR operates are solely left to individual governments.

Dr. Apollos Nwafor
Vice-President
Policy and State Capability
AGRA

Executive Summary

Globally, volatility in food prices driven by the effects of climate change, the COVID-19 pandemic, and the Russia-Ukraine crisis has aggravated food insecurity risk and caused price hikes in international and domestic food markets. These concerns have re-ignited discussions on the role of national food reserves in stabilizing food supply and prices during disruptions of food supply systems.

In 1987, the Federal Government of Nigeria (FGN) launched a three-tier storage policy comprising On-Farm Storage Program, Buffer Stock, and the Strategic Grains Reserve (now known as Strategic Food Reserve) to address the emergency crisis and to support vulnerable groups. The first set of five silo complexes of 25,000MT each were constructed in 1987 under the National Strategic Grains Reserve Program and a sixth silo complex of 11,000MT was later acquired, leading to a combined capacity of 136,000MT. Some of these silo complexes have been in operation since 1992, with varying degrees of success in response to emergencies and price stabilization needs. Presently, there are 33 Federal Government owned silo complexes, with a combined capacity of 1.336 million MT when completed, and 51 warehouses with a combined capacity of 108,000MT.

The Federal Reserve has over the years employed tools such as Buyer of Last Resort (BLR), Licensed Buying Agents (LBA), Guaranteed Minimum Price (GMP), Direct Contract (DC), and other approved procurement procedures to provide food relief in times of natural or man-made disasters and to provide safe, available, and accessible food.

In an effort to create a responsive, sustainable, and more effective food reserve system, the Federal Government of Nigeria commissioned this study in collaboration with AGRA to determine the optimum sustainable capacity of storage and optimal stocks, among other objectives, to meet the country's needs.

The main purpose of the study was to review National Strategic Grains Reserve Program mainly focusing on the legal and policy framework, the political structure, its operations, the management structure, and achievements over the years. Further, the study reviewed the Reserve's nationwide storage capacity and ownership, and sources of stored produce (both private and public). The conditions of the infrastructures of the government-retained silo complexes were assessed and the cost estimate to rehabilitate them was determined. Further, the optimal sustainable capacity and stocks with suitable management models aligned to global best management practices are recommended.

A mixed-method approach involving the collection of primary data combined with a literature review was used to gather information relevant to the study objectives. Data collected were analysed, corresponding gaps and weaknesses were identified, and recommendations were made for the achievement of a more effective and efficient SGR system in Nigeria.

The following are the key recommendations from the findings of the study: -

1) *Optimal stocks of 414,425 MT to offset the shortfall in supply.*

   Using 10-year historical data from 2010 to 2019 with a 95% target level of consumption, the sustainable optimal stock and storage capacity were estimated to be 414,425MT and 2,564,098MT, respectively. **Thus, the optimal Capacity of Emergency Reserve of 2,564,098 MT for vulnerable groups; and, Buffer stocks Capacity of 1,323,000MT for minimum food security requirement for six (6) months.**

   Nigeria, with an estimated population of more than 200 million, requires a stock level (established total Optimal Buffer Stock capacity) of 2,646,000MT of grains in a year to meet the minimum food security requirement. The stock in the emergency reserve of Nigeria at the time of the study was 100,000MT, which is just 7.6% of the required six months provision of 1,323,000MT for minimum food security requirements. Also, the present storage capacity ranging

from 225,000MT to 333,000MT from government-managed structures is inadequate.

2) Aggressive involvement of the private sector in the reserve system is advocated. **The private sector should be incentivized through the timely availability of required information, enhanced ease of doing business, and adherence to contractual terms**.

Currently, the Federal Government of Nigeria (FGN) has a total of thirty-three (33) food reserve silos with a combined storage capacity of 1.336 million MT when fully operational and fifty-one (51) warehouses.

The findings from this study show that the Food & Strategic Reserve Department (FSRD) has been unable to utilize the available storage capacity, largely due to budgetary constraints among other reasons. This low-capacity utilization necessitated the Federal Government of Nigeria to concession seventeen (17) silo complexes with a total capacity of 636,000MT to five (5) private investors for a ten-year (10) period (September 2020 to September 2030) to maximize storage space utilization for the Reserve, in addition to revenue generation. The six (6) silo complexes retained by FGN, are spread within five geo-political zones of Nigeria, with a combined capacity of 225,000MT. Thus, following the concession, most of the SGR storage infrastructures in Nigeria are presently managed by the private sector, utilizing them for their industrial purposes. Additionally, the 6 silo complexes retained and managed by the FGN require upgrading in line with modern technologies. An estimate of $904,963.05 (as of July 2022) will be required for upgrade/rehabilitation.

3) *Government should consider holding both a dedicated Fund (financial) and physical stocks.*

Given the high cost of keeping physical stocks (stocking, management, and destocking), the government should consider holding both financial (a dedicated Fund) and physical stocks. This allows for the stability and flexibility of food interventions. **Contributions to the Financial Reserve could come in the form of budgetary allocations from the government, revenue from operations of the reserves, and donations/ endowments from both the private and the sectors**. The current fund bill in parliament to finance the agriculture sector is also another vehicle to support the dedicated Fund to the SGR.

4) *Develop requisite legal instruments for the FSRD to operate more flexibly or upgrade the FSRD to a Class A Parastatal.*

The FSRD should be restructured and empowered with the requisite legal instrument to operate more flexibly. Alternatively, **the FSRD could be upgraded to a class A parastatal.** The upgrading will require the government to increase public funding to the Food Reserve, either through annual budgetary allocations or through fast-tracking the conclusion of the legislation for the National Agricultural Development Fund (NADF) and prioritizing the Strategic Food Reserve for funding by the NADF.

Government bureaucracy, inadequate funding, and skill gaps in food reserve management were identified as some of the main obstacles to an efficient and responsive food reserve system in Nigeria. The present organizational bureaucratic structure of FSRD does not encourage business or economic/ commercial partnerships with the private sector that could lead to a more efficient Reserve System (see recommendation 5 below). Hence, the need for legal and institutional reforms.

5) *A Public Private Partnership (PPP) economic model that allows the private sector and value chain actors to participate in the SGR.*

Government should adopt a Public Private Partnership (PPP) economic model that allows the private sector and value chain actors to participate in the supply and off-take of stock on a commercial basis directly from FSRD should be encouraged for the effectiveness and financial independence of the Reserve.

6) *Improvement of a market information system.*

Improvement of a market information system through the **development of a platform (preferably mobile-linked) to facilitate the continuous collection of data** from farmers, traders, and other stakeholders and to make the data available for analysis and decision-making.

1 Introduction

1.1. Background

One of the first acts of any permanent human settlement is likely to be the creation of grain reserves (David J. Eaton, 1980). Early humans, as hunters and gatherers, moved with the seasons and their prey. Agriculture, and the implicit security of a renewable source of food, led people to settle in one place. The discovery of the buffer stock idea encouraged permanent human settlement. The management strategy of Biblical Joseph, and Li K'o, who lived in China in the 12th Century exemplified the need to stabilize supplies of grains/food through good and lean years. The role of the reserve in mediating supply and price fluctuation will remain relevant as long as the weather continues to influence the security of food production.

At the 2003 African Union Summit, African Heads of State expressed deep concern at the deterioration of the food security situation in many of their countries[1]. They resolved to take action on a number of fronts to resolve the problem. The meeting launched a study of food-reserve systems with a view to identifying actions that could be taken at the regional level to ensure the adequacy of food supplies at all times and all places, and access by food-insecure people to the food they need. The NEPAD study on food reserve systems in Africa focused on eight countries representative of the Sahel, East and Southern Africa and the Horn of Africa. Among other national measures, the following were highlighted:

- *Physical reserves should have financial components for purchasing urgently needed food from places close to the area of operation where there are surpluses, and for covering management and logistics costs.*
- *National early-warning and food-security information systems should be established or strengthened to provide reserve managers with credible and timely information about harvest prospects, potential food shortages and relief food needs of the vulnerable population.*
- *Private stock-holding should be encouraged through measures such as promoting greater use of traditional on-farm storage technologies with low rates of post-harvest loss, promoting pilot schemes to provide farmers with credit against warehouse receipts for stored grain and encouraging the development of local milling and processing capacity.*
- *Governments should make clear their commitment to creating an enabling environment for the development of domestic agricultural markets, including (i) committing to refrain from imposing cumbersome regulations on internal and cross-border trade and (ii) facilitating the transparent circulation of information about market conditions.*

Globally, Strategic grain reserves, also called emergency food reserves or food security reserves, received considerable attention following the global food crisis of 2007–08 (Shahid et al., 2010). The resulting volatility in food prices led to price hikes in global and domestic food markets and seriously affected poor peoples and countries adversely, and occasionally led to political instability. These concerns gave rise to the concept of developing a Food Reserve proposed to be coordinated by the World Food Programme (WFP) (Würdemann, Meijerink et al. 2011).

At the African Continental level, the Economic Community of West African States (ECOWAS) established a regional reserve in 2014 to respond to and prevent food crises in the region, promote regional integration and reduce price volatility for the benefit of producers and consumers. This Regional Reserve is still evolving but has achieved a certain degree of success. One of its four Reserves was established in Nigeria. During the COVID-19 pandemic, the ECOWAS reserve gave food aid (assorted grains) of 3,308MT to Nigeria, in addition to 5,000MT loaned from the Reserve on a grain-to-grain rotation basis.

1 NEPAD 2004. Study to explore further options for food-security reserve systems in Africa. New Partnership for Africa (NEPAD) and the United Nations World Food Programme, Rome

An IPFRI study focused on four country case studies in Africa (Ethiopia, Kenya, Malawi, and Mali) found that a strategic reserve is necessary to address shocks, such as the prolonged droughts in the countries of Sahel region[2]. The study further operational performance and costs vary across countries depending on the institutional design, stock level, and integration with social safety. The cost of holding a metric ton of food varied from US$ 20 to US$ 46 across the countries in the study. The impact of increasing stock levels on market prices and subsidy bills is not negligible.

Prices can be depressed by 10–40 percent depending on stock size, rotation mechanism, and storage locations. Nevertheless, integration with social safety nets, such as school feeding or food for education programs, can generate local demand, which under certain conditions can boost production and contribute towards smallholders' income.

Several countries in Africa operate Strategic Food Reserves (SFRs). Ethiopia, for example, established the Emergency Food Security Reserve (EFSR) in 1982 and has been managed by an autonomous administration (the EFSRA) since 1991. It releases grains to approved agents either as relief or loans to be paid in kind. The Ethiopian Government carries the cost of EFSRA's management and maintenance. The model is replicated in Niger, Malawi and Mauritania. Governments in Southern African countries have continued to intervene in grain markets, sometimes discouraging structural development of private trade as in Tanzania and Zambia, while Malawi competes in the open markets.

National food reserve systems have been criticized as costly, inefficient, and impeding the development of domestic markets. It has been observed that a major constraint in the use of stabilization reserves is the high fiscal cost, which exceeds the budgetary capacities of many countries (Nick Maunder, 2013). Many countries have been evolving dynamic solutions to food shortages, some of these innovative approaches were aimed at improving food security and market functioning and were developed as a complement to emergency food reserves. Some of the instruments include trade insurance to remove credit constraints in regional trade; use of warehouse receipts to cover credit requirements in the chain; (e.g., in Ivory Coast, Mali, Mauritania, Zambia and the East African Grain Council); market information systems; and donor financing of local purchases (e.g., the Purchase for Progress or P4P programme of WFP).

1.2. Evolution of Strategic Food Reserves in Nigeria

The Food Strategic Reserve Programme in Nigeria was designed to provide food relief in times of emergencies, both locally and internationally, to provide a ready and accessible market for locally produced food items through the Buyer of Last Resort (BLR), and to maintain price stability to enhance food security.

Between 1970-1985, the priority of the Nigerian Government Policy was to increase agricultural production. This led to the establishment of the Agricultural Commodity Marketing and Pricing Policy of 1977, and the establishment of six (6) National Commodity Boards (Cocoa, Groundnut, Palm Produce, Cotton, Rubber and Food Grains). In 1986 the Structural Adjustment Programme (SAP) was launched. This resulted in trade liberalization in 1987 and the abolition of Commodity Boards.

In 1987, the government of Nigeria launched a three-tier Storage Policy:

i). On-farm Storage Programme – was expected to handle 85% of food grains produced in the country and to encourage local farmers to reduce post-harvest losses. Farmers were expected to store part of their food production and sell it for better prices long after harvest. The government in collaboration with partners and through the Crop Storage Unit (CSU) - established in 1987 - trained extension officers and households on improved farm storage, which led to the adoption of improved on-farm storage structures for grains and other agricultural products. However, the lack of continuity, and follow-up extension activities, eroded its degree of success.

ii). Buffer Stock - the State Governments have the responsibility for implementing the Buffer Stock which was designed to store 10% of the food grains produced and use it to stabilize the market prices at the state level. The Federal Government of Nigeria (FGN) at its inception provided support to the state governments by providing

2 IFPRI (2010). Strategic Grain Reserves in Africa. https://www.ifpri.org/blog/strategic-grain-reserves-africa

designs of improved commodity storage warehouses and funds for its implementation. A survey conducted in 2018 revealed that most states did not fully embrace the programme. However, only a few states like Niger, Gombe, Kano, Kebbi and Oyo had Buffer Stock warehouses in place., Despite tremendous support from the FGN, all the state governments could not adopt the Buffer Stock Programme because of a lack of political will.

iii). The Strategic Grains Reserve (now known as Food and Strategic Reserve) is the responsibility of the Federal Government. It is expected to keep 5% of the total annual food grains production for emergency food intervention and complement the price stabilization programme. It is used to address emergency crises and to support vulnerable groups.

In 1998, an Agricultural Policy that focused on macro policy-pricing, trade exchange rate and agricultural land policy including Agricultural Sector and Support Services Policy was launched. In 1995 the establishment of the Commodity Exchange (COMEX) was approved leading to the establishment of the Abuja Stock Exchange (ASE) in 1998. Its name was changed to Nigerian Commodity Exchange (NCX) in 2021 with the Central Bank of Nigeria taking over the management. Between 2014 and 2022 four private commodity exchanges were established African Exchange Holdings (AFEX), Prime, Lagos, and Gazawa).

1.3. The Rationale for The Study

Many countries are now faced with an imminent food crisis that emerged from the outbreak of the COVID-19 pandemic which is further aggravated by the ongoing conflict between Russia and Ukraine. The ripple effects of these activities have caused disruptions in the food supply systems. Therefore, the lessons from the experiences gained necessitated putting measures in place to determine the optimal stock levels of various food commodities in the food reserve structure of the country and having in place systems and seasonal calendars for stocking and drawdowns.

The Chairman of the Senate Committee on Agriculture in the 9th Assembly, Senator Abdullahi Adamu, in May 2020, concerned with the need to cope with future situations of emergencies, sponsored a Bill for the establishment of a National Food Reserve Agency (NFRA). The Bill was passed by the Senate and is awaiting the concurrence of the House of Representatives of the Federal Republic of Nigeria. It is aimed at enhancing food security for Nigeria and averting any form of emergency food crisis in the future. The Bill proposes the establishment of the Food Reserve Agency which will be responsible for storing food grains and other food commodities for strategic purposes. The Agency will address emergency food crises and stabilization of food prices.

Currently, the Federal Ministry of Agriculture and Rural Development (FMARD) and the Food and Strategic Reserve Department (FSRD) have the responsibility to build up the FGN grain reserves and develop strategic food stocks, to respond timely to food security crises. The use of cereals (maize and sorghum, millet, rice paddy, soybean and processed cassava known as "*Garri*") under the FSR government policy has been a major policy instrument to enhance food security over the years. However, the government has been unable to stock the available storage space in the reserve to full capacity, due to budgetary constraints. Presently, the government-controlled strategic reserve silos have about 100,000 MT of grains in stock. The government has also concluded the concession of 17 out of its 33 silos to the private sector.

Against this backdrop, it has become necessary to review the current management and the operations of the strategic food reserve in Nigeria to propose the best management option that will enable the reserve to achieve its objectives, thus the necessity for this study.

1.4. The Objectives of the Study

The primary objective of the study is to identify key issues around policy, storage, and management of Strategic Food Reserves for improved efficiency of the food reserve and better preparedness in food emergencies and other shocks and stresses. Specifically, the study was designed to:

i). Review and develop best models for the economic sustainability of the country's Strategic Grain Reserve; the linkage between the private and public sectors for the benefit of the reserve; engaging small agriculture producers in the country's reserve.

ii). Develop a framework to improve the management and operations of an effective and functional Strategic Food Reserve in a manner that will enable it to respond to any emergency as quickly as possible and at the same time provide appropriate price stabilization and safety net options in periods of need.

iii). Assessment of the current physical status of the silo complexes, warehouses and other storage infrastructure will be provided.

iv). Determine the optimal stocks for strategic food reserves against Nigeria's current needs for emergencies and price stabilization.

v). Develop partnership models with the private sector meant to enable the involvement of the private sector in the regional and national FSRs.

vi). Develop a business model to link small agricultural producers with SGR.

2 Review of the food security situation in Nigeria

2.1 Trends in Food Production and Food Security

Since the outbreak of COVID-19, studies in a sample of 30 countries, showed a median decline of 2.8 in GDP in 2020 (Fernandes, 2020). "A baseline global pandemic scenario study predicted a GDP decline of 2% below the benchmark of the world, 2.5% for developing countries and 1.8% for industrial countries" (Maliszewska, et al., 2020).

The ongoing food crisis has left 27 million people in West Africa in a state of hunger and this number could increase by 11 million before the end of 2022 (OXFAM, 2022). The report stated that between 2007 and 2022, the number of people in need of food assistance in the West African region including Nigeria, Mali, Burkina Faso, Chad and Niger increased from 7 million to 27 million. It further warned that unless emergency action is taken, the figure could rise to 38 million by June, based on data from Cadre Harmonise March 2022 report.

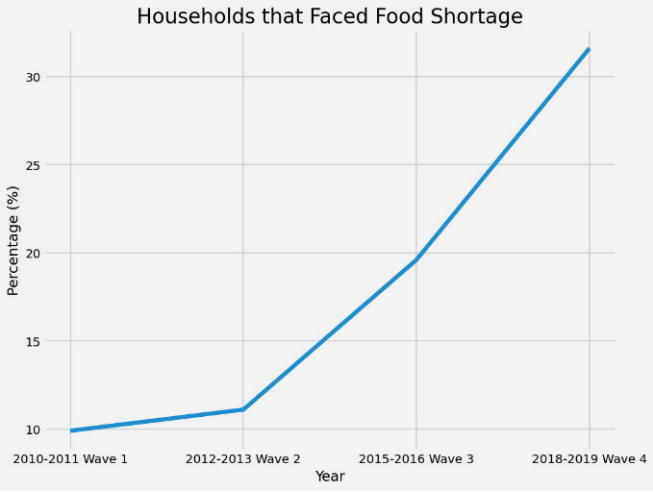
The food systems in West Africa are characterized by low production and productivity, weak infrastructure, and the absence of good data and evidence coupled with high levels of policy unpredictability in food markets. In Nigeria, food insecurity is heightened by the continuous insurgency in the Northeast of Nigeria leading to millions of people being displaced from their ancestral homes and farms with no access to any means of livelihood.

The number of households faced with food insecurity and undernourishment has been growing steadily in the last decades (Figure 1). In one decade alone, the number of households experiencing food shortage increased from barely 10% in 2010-2011 to over 31% in 2018-2019. Reducing food insecurity and structural vulnerability of the population with social safety nets is critical. There is a need to strengthen the national instruments to timely support capacities to prevent and manage food crises, and thereby reduce the vulnerability of the poor, rural and urban populations..

2.2 Drivers of Food Insecurity and Undernutrition in Nigeria

2.2.1 Population and Food Production

The Federal Republic of Nigeria has a population of approximately 201 million people making it the most populated country in Africa and the seventh (7th) most populous country in the world. An increase in the population often drives-up demand for food. Figures 2 and 3 show trends in the population growth rate and food production index in Nigeria (2000-2020). In the period 2000-2020, Nigeria witnessed an increased rate of popula-



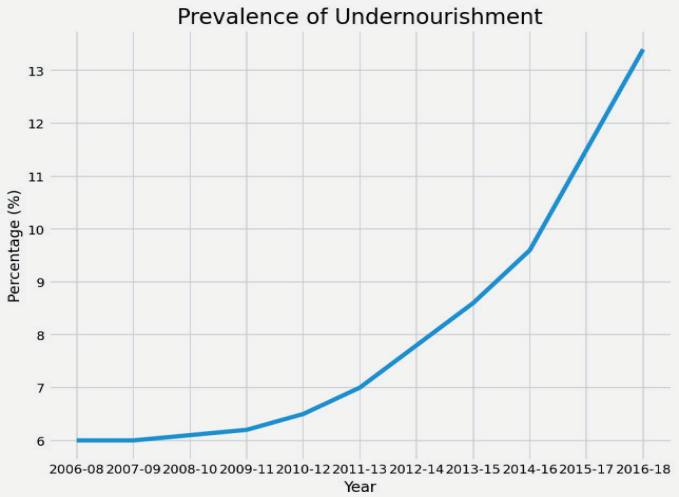


Figure 1: Food Insecurity and Undernourishment.

Source: Food Insecurity in Nigeria: An Analysis of the Impact of Climate Change, Economic Development, and Conflict on Food Security (Kralovec, S. 2020)

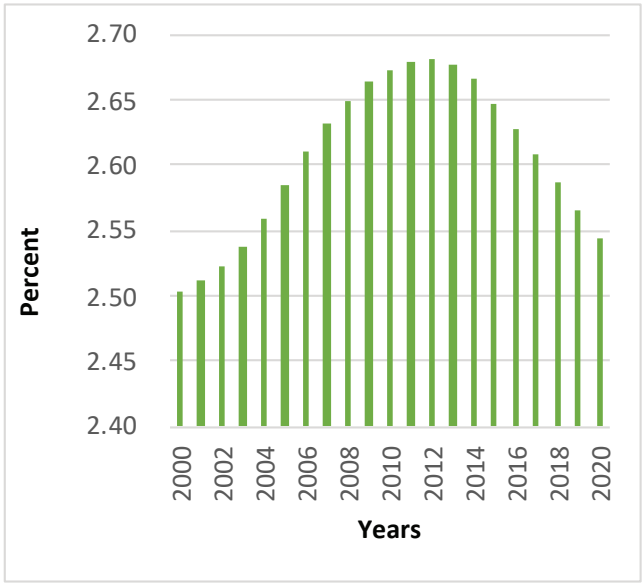


Figure 2: Nigeria's population growth from 2000-2020.
Source: World Bank Database 2021 https://data.worldbank.org/indicator

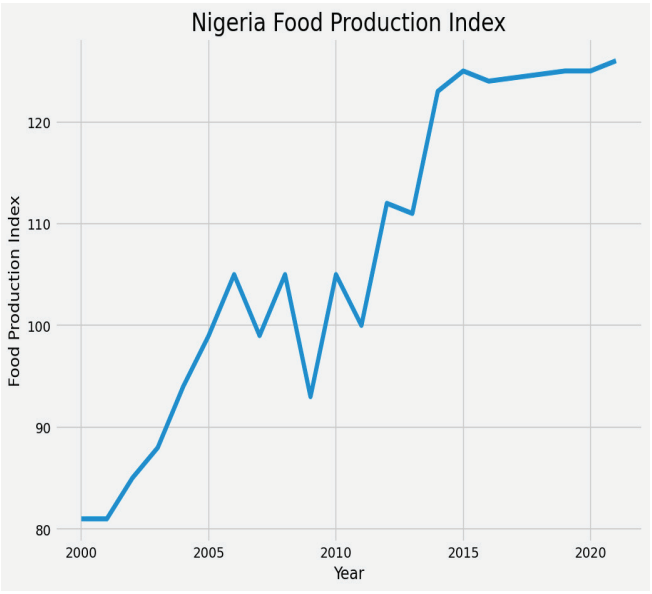


Figure 3: Food production index in Nigeria from 2000-2019.
Source: World Bank Database 2021 https://data.worldbank.org/indicator

tion growth without a commensurate growth rate in food production. The population growth rate was highest in 2011/2012. In the years 2013 and 2020, there was a decline in the annual population growth rate in Nigeria, however, the Nigeria food production index in the same base year 2013, for instance, did not increase significantly to positively impact the teeming population in meeting the food needs.

Nigeria's food production index has not only been stable progressively and even when it increases, it has not been significant enough to address the need of the increasing population as discussed above. The implication of this is a high demand for limited food leading to food insecurity.

2.2.2. Climate Change

In recent years, one of the impacts of climate change has been excessive flooding in many countries of the world including Nigeria. Flooding of farmlands results in poor or no harvest and hence aggravates food insecurity and displaces the population in the affected areas. The resultant effect is an increase in the number of vulnerable people that are prone to food insecurity thus more pressure on the nation's strategic food reserve as is the case in Nigeria at present.

Figure 4 below shows the number of IDPs in Nigeria over the years. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) situation reports showed that the year 2012, experienced the worst flooding in more than 40 years as a result of climate change. In 2012, there were almost 4 million IDPs due to weather disasters and according to the Internal Displacement Monitoring Centre (IDMC), most of them were affected by floods.

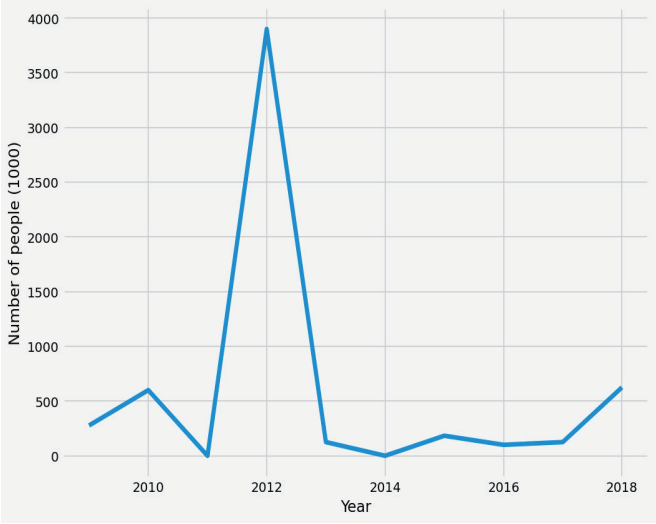


Figure 4: IDPs Due to Climate-related Disasters.
Source: Food Insecurity in Nigeria: An Analysis of the Impact of Climate Change, Economic Development, and Conflict on Food Security (Kralovec, S. 2020)

2.2.3. Economic Growth, Inflation, and Unemployment

As shown in Figure 5, the rate of economic growth dropped substantially from 8% in 2010 to negative figures in 2016, before rebounding to 2 percent in 2018. At the same time, unemployment has been growing steadily since 2013. Food inflation has also been high, with an average of above 10% since 2016 (Figure 5). Unemployment drives many households into poverty, which is a leading cause of food insecurity. Additionally, higher food prices make food inaccessible to people causing more people to slide into poverty.

2.2.4. Violent Conflicts

Nigeria has faced a rising number of conflicts caused by the Boko Haram Insurgency since 2009. The year 2014 not only saw the most conflicts but it was also, by far, the year with the most deaths from the conflicts. Close to one million Nigerians were displaced due to conflicts in 2014; the highest displacement in the past twelve years. The conflict led to a significant increase in the number of Internally Displaced Persons (IDPs), as shown in Figure 6 (number of IDPs due to conflict), which has greatly affected the food situation in Nigeria.

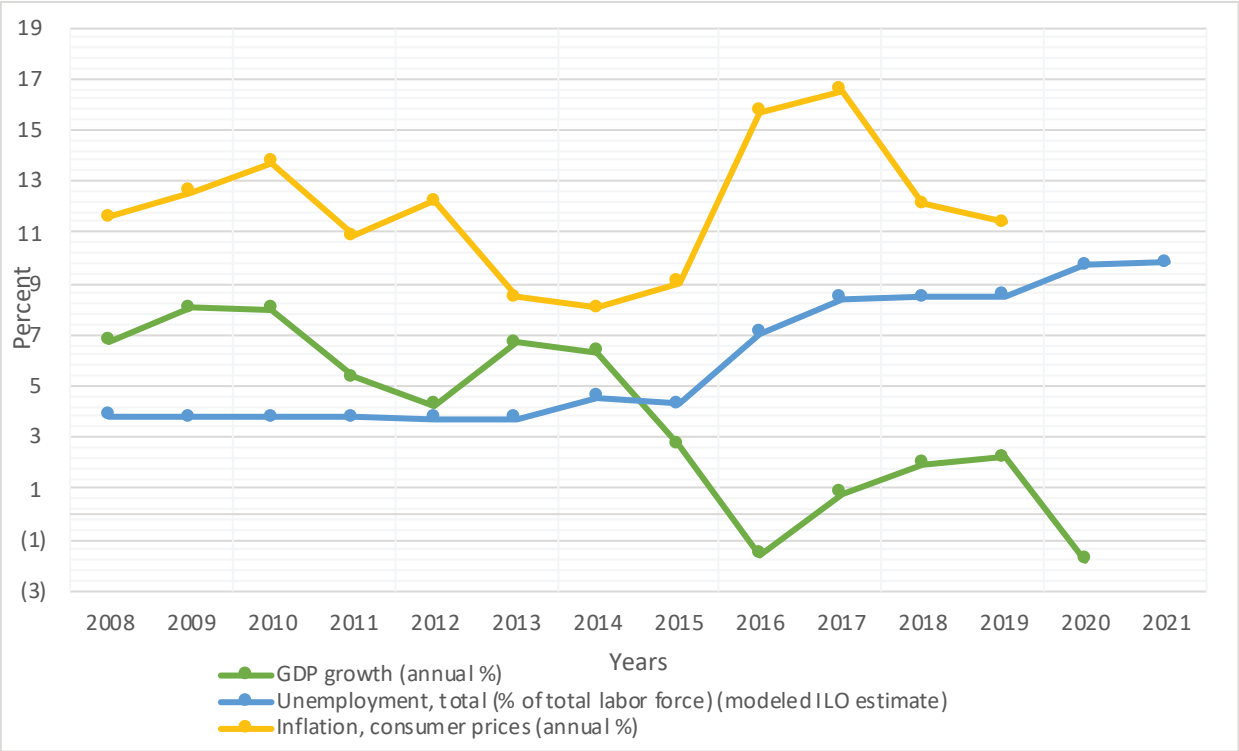


Figure 5: Nigeria Annual GDP Growth, Unemployment Rates and Inflation 2008-2021.

Source: World Bank Database 2021 https://data.worldbank.org/indicator

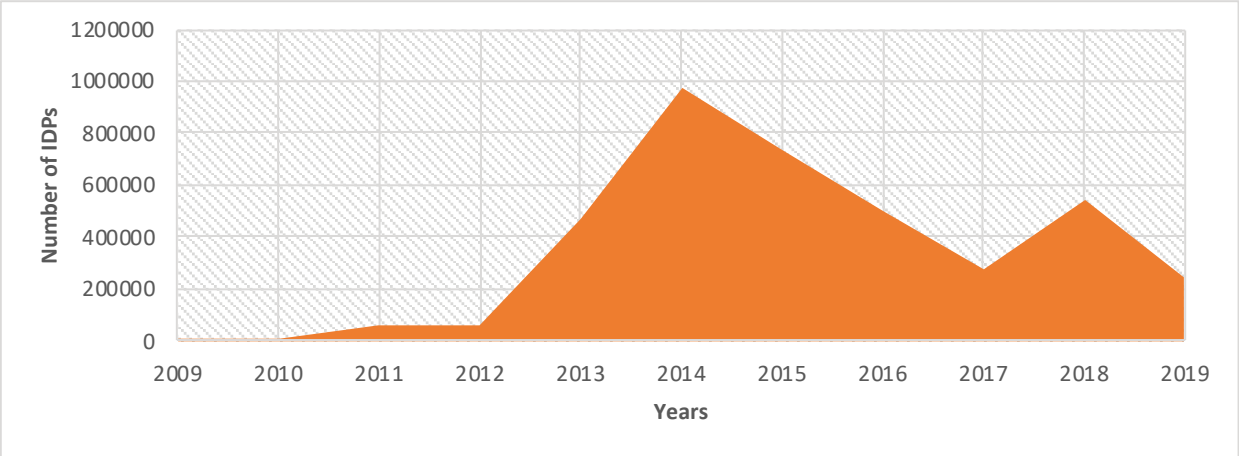


Figure 6: Number of IDPs due to Boko Haram insurgency.

Source: Food Insecurity in Nigeria: An Analysis of the Impact of Climate change, economic development, and conflict on food security (Kralovec, S. 2020)

2.3 Options for Food Support for the Vulnerable Populations in Nigeria

2.3.1 Cash and Food Transfer

Food transfer is one of the tools that have been effectively employed by the FSRD in addressing emergencies and hunger among the vulnerable population in Nigeria. Some MDAs such as the Ministry of Humanitarian Affairs, Disaster Management and Social Development; the Federal Ministry of Finance, and Budget and National Planning among others currently implement cash transfers to vulnerable groups. Some of the successful food transfer activities under the FSRD are contained in Table 1.

Table 1: Stock Releases 2009-2022

Year[3]	Commodity	Qty (MT)	GMP[4] (₦)	CBN E.R $1 to ₦	Value in USD ($)	Purpose (emergency, etc.)	Comments
2022	Maize	20,000	315,000	416.00	15,144,230.77	Price support and Emergency	5,000 MT to Poultry; Distributed to IDPs /women groups
	Sorghum	12,000	310,000	416.00	8,942,307.69		
	Millet	5,000	315,000	416.00	3,786,057.69		
	Garri	3,000	242,000	416.00	1,745,192.31		
2020	Maize,	40,000	147,000	361.00	16,288,088.64	Emergency	Assistance from World Food Programme (WFP).
	Sorghum	20,000	140,000	361.00	7,756,232.69		
	Millet,	5,000	160,000	361.00	2,216,066.48		
	Garri,	5,000	242,000	361.00	3,351,800.55		
	Assorted cereals	3,308.50			Not Applicable	Emergency	Donation by ECOWAS to FGN
2019	Maize	5,000	147,000	305.00	Not Applicable	Vulnerable support	Food assistance to Sokoto, Zamfara, Benue and Bayelsa States. (Loan from ECOWAS)
	Sorghum		140,000	305.00			
	Millet		160,000	305.00			
	Garri		242,000	305.00			
2018	Millet	2,000	160,000	360.00	888,888.89	Vulnerable support	World Food Programme (WFP) food assistance
	Assorted food commodities (Maize, Sorghum, Millet and Garri)	3,180		360.00	Not Applicable	Vulnerable support	To Internally Displaced Persons (IDPs) in Nasarawa and Benue States
2016	Maize	10,000	169,000	310.00	5,451,612.90	Vulnerable support	Internally Displaced Persons (IDPs) in the North-Eastern part of Nigeria
2014	Maize	700		184.50	Not Applicable	Emergency	Food assistance to the Namibian government
	Milled Rice	300		184.50	Not Applicable	Emergency	Food assistance to the Namibian government

3 Years 2021, 2017, and 2015 were not included because of a lack of activities.

4 GMP is the procurement price

Year[3]	Commodity	Qty (MT)	GMP[4] (₦)	CBN E.R $1 to ₦	Value in USD ($)	Purpose (emergency, etc.)	Comments
2013	Maize,	11,500	66000	158.06	4,801,973.93	Emergency	Distributed to states under emergency due to insurgency (Borno, Yobe and Adamawa)
	Sorghum	4,500	63000	158.06	1,793,622.67		
	Millet	2,500	75000	158.06	1,186,258.38		
	Garri	1,000	118000	158.06	746,551.94		
	Garri	1,000	118000	158.06	746,551.94	Emergency	Donated by the Federal Government of Nigeria to the Republics of Chad and Niger
	Assorted grains	1,000		158.06	Not Applicable	Emergency	Donated by the Federal Government of Nigeria to the Niger Republic
2012	Maize	40,000	35,000	158.30	8,843,967.15	Emergency	To Internally Displaced Persons (IDPs) in the states affected by floods.
2011	Sorghum	5,000	63,037	158.78	1,985,042.20	Emergency	Food assistance to the Republic of Chad
	Sorghum	10,000	63,037	158.78	3,970,084.39	Emergency	Food assistance to the Republic of Niger
	Sorghum	30,000	63,037	158.78	11,1910,253.18	Emergency	World Food Programme (WFP) for Emergency Food Relief to the Republics of Chad and Niger

Source: FSRD FMARD, 2022

Apart from FSRD, other organizations/Apart from FSRD, other organizations/programmes that deal with food intervention/transfer activities are National Emergency Management Agency (NEMA) and National Home-Grown School Feeding Programme (NHGSFP). However, food transfer programmes are inefficient and costly. Many governments of developing countries are now adopting cash transfer programmes.

2.3.2. Home Grown School Feeding Programme - A Social Safety Net

The Nigeria Home Grown School Feeding Programme School (NHGSFP) is being implemented to address and complement the intervention of FSRD in ameliorating the challenges of vulnerability to food and nutrition security, by providing free food for children of the poor in public schools. The programme was launched in 2016 to provide at least one quality meal a day for children in public schools. The objective of the programme was to increase enrollment, reduce the dropout rate, and ensure quality learning outcomes (Adekunle & Christiana 2016). By connecting the programme to local food supply chains, the community is engaged to create social support beyond simply providing meals to the children (Okolo-Obasi E. N., Uduji, J. I., 2022).

The School Feeding Programme in Nigeria has led to improvement in the health and educational outcomes of public primary school pupils. It was reported that over 300 million meals were served to more than 7.5 million pupils in 46,000 Public Primary Schools in over 30 states since 2016 (Punch, 2020), and over 44,000 cooks were engaged in the programme. However, the Programme has challenges like inadequacy of funds.

2.3.3. National Emergency Management Agency - Food Intervention in Stocks

The National Emergency Management Agency (NEMA) was formed with a vision of building a culture of preparedness, prevention, response and community resilience to disasters in Nigeria. NEMA's objective is to coordinate resources towards prevention, preparedness, mitigation and response in Nigeria in relation to disasters.

NEMA supplied food items to the IDP camps in the North-East of Nigeria (Raji, S., et al, 2021) and released funds to purchase 200,000 bags of maize, 50,000 bags of rice and 250,000 bags of millet for distribution to the IDPs camps in Borno, Yobe, and Adamawa States, with Borno allocated more than half of the food items because of a larger concentration of the IDPs in the state.

3 Review of the SFR System in Nigeria

3.1 Establishment of the Food and Strategic Reserve Department

The Food and Strategic Reserve Department (FSRD) of the Federal Ministry of Agriculture and Rural Development was established through a statutory mandate by the Federal Government of Nigeria. There is currently no Law or Act establishing the Reserve. It was originally established as a Unit in the office of the Honourable Minister, Federal Ministry of Agriculture and Rural Development in 1994, and managed by Military Task Force. It was later upgraded to a full Department in the Year 2000. The department operates within the Civil Service structure.

The Department has a responsibility for the procurement and distribution of the mandated food grains (maize, sorghum, paddy rice, millet, and soybean) and "*garri*" in collaboration with the Procurement Department of the Ministry. It implements the Buyer of Last Resort programme and the Guaranteed Minimum Price (GMP). It also has the responsibility for silo construction and management. In addition, the Department implements the food relief programme, and the rotation of food stocks after the ideal storage period; to cushion citizens from the effect of food price volatility and the high cost of food. It does emergency and regular procurement. In addition, it collaborates with other professional and service departments of the Federal Ministry of Agriculture and Rural Development, Research Institutes, the Universities and Colleges of Agriculture and other Departments and Agencies of FMARD.

Gaps and Weaknesses

1). There is no legal instrument backing up the FSRD to operate as an autonomous government agency and as a Department in the Federal Ministry of Agriculture and Rural Development, its authority is limited and subject to the bureaucratic procedures of the Ministry.

2). The Procurement Act does not allow for flexibility and accommodating innovations in the stocking of food grains most especially through direct procurement from farmers' associations, online trading for purchases and releases, and the Warehouse Receipt System (WRS).

3.2. Organizational Structure and Management of Food Reserves in Nigeria

The FSRD has the statutory responsibility of managing the Strategic Food Reserve of the Federal Government of Nigeria. It is headed by a substantive Director who is a civil servant and has no financial authority except such expenditures as approved by the Permanent Secretary who is the Ministry's Accounting Officer. The operational structure which represents the hierarchical order for approvals of operations and the Organizational Structure (organogram) of FSRD are presented in Figures 7 and 8 respectively.

The Organogram of the FSRD as presented below shows that it has one directorate, and five divisions, with ten units that oversee the fifteen program levels arms operating in the department. The department has service units that cater for the administration and maintenance within the department as shown in 7 and 8. The five (5) main divisions are headed by five (5) Deputy Directors namely, Price Stabilization Program; Strategic Food Reserve; Emergency Food Supply and Logistics; Nutrition and Food Access; and School Feeding Program Divisions. The Director of the Department reports directly to the Permanent Secretary. The day-to-day running of the Department is the responsibility of the Director assisted by the Deputy and Assistant Directors. The Director also oversees the activities of Silo Managers and gives necessary directives as the occasion demands. The Silo Managers are responsible for managing the food commodities in the silo or other storage structures in safe and healthy conditions.

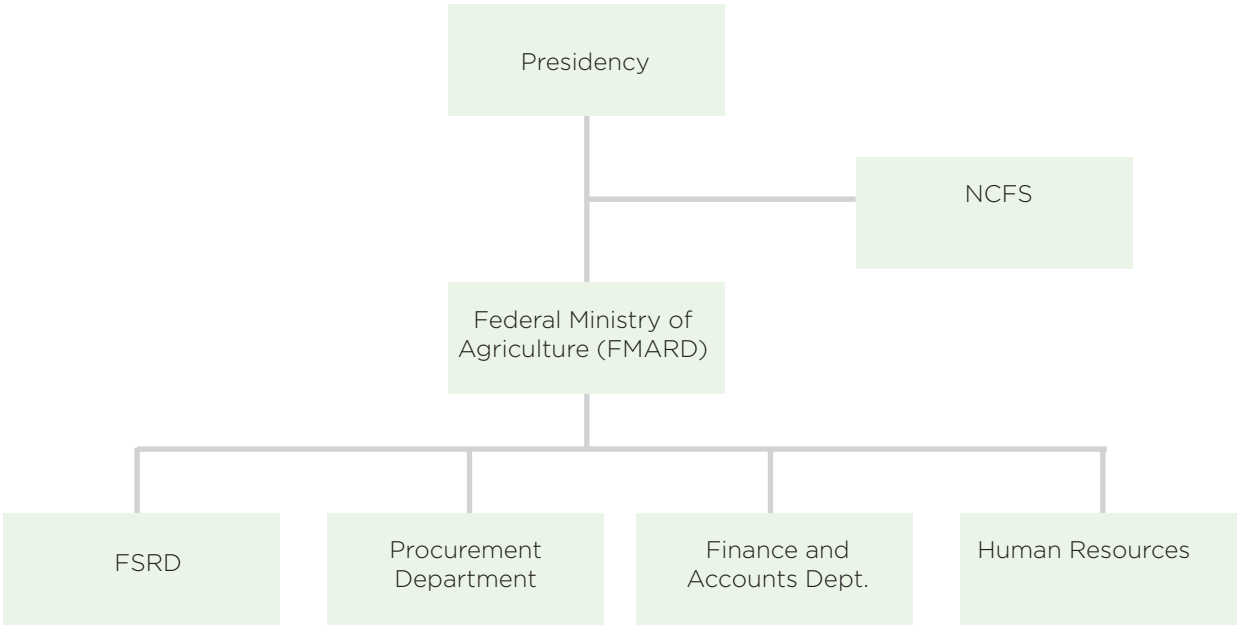


Figure 7: Operational Chart of FMARD.
Source: Food and Strategic Reserve Department, FMARD, 2022

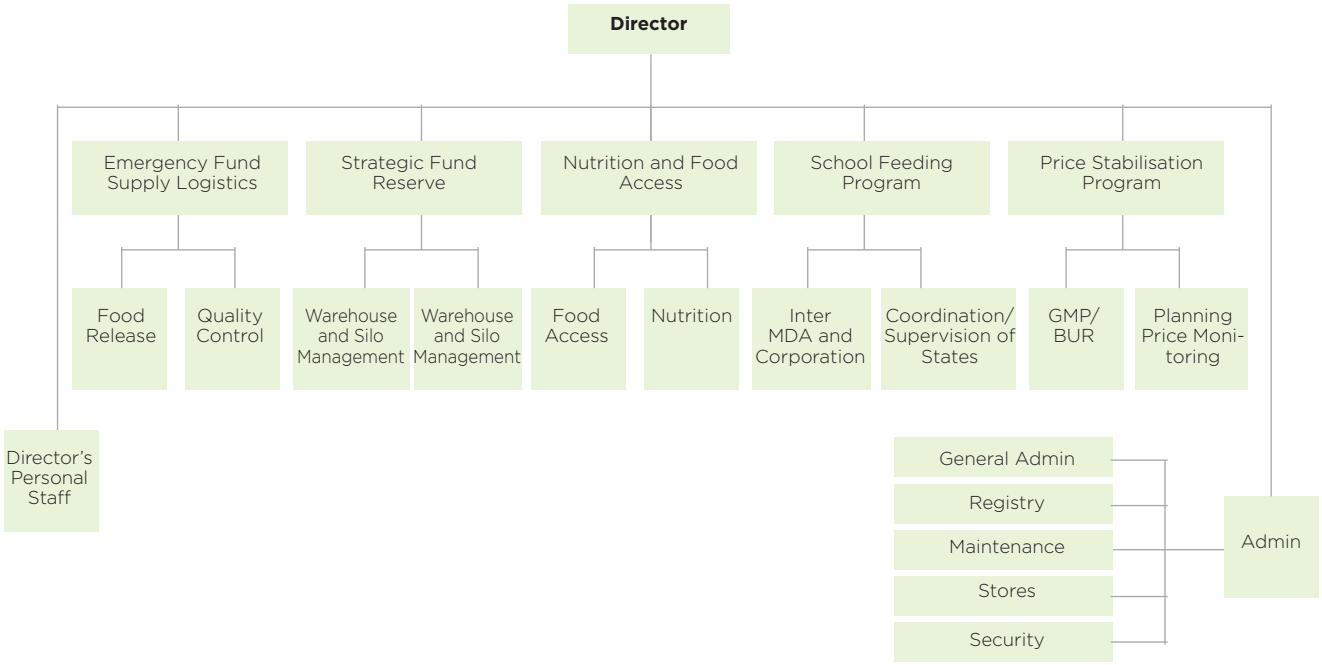


Figure 8:Organogram of the Food and Strategic Reserve Department.
Source: Food and Strategic Reserve Department, FMARD, 2022

The decision to stock and destock the silo complexes with and release food commodities is normally approved by the President of the Federal Republic of Nigeria based on the recommendation of the Minister.

Gaps and Weaknesses

The long bureaucratic chain in a typical Civil Service structure which is the current institutional arrangement of the FSRD poses a challenge to quick response to the issue of stocking and destocking of food commodities in its Reserve.

3.3 Operational System of the Food Reserve in Nigeria

In its policy objective, the FSRD aims to procure and hold 5% of food grains produced in Nigeria (maize, sorghum, millet, soybean, paddy rice), and *garri* (grated cassava tubers, fermented and fried to a moisture content of about 8% for storage). Collaborative efforts of various governmental organizations and the market price monitoring unit of FSRD provides informed decisions on when to procure (stock) and release (destock) food from the reserve. Such governmental organizations include among others; the National Bureau of Statistics, the Central Committee on Grains and other commodities prices in the Office of the Secretary to the Government of the Federation.

Food procurement is done through Licensed Buying Agents (LBAs) after the GMP Inter-Ministerial Committee of FMARD completes a market survey and establishes a GMP at which LBAs are expected to buy from the farmers and deliver the grains to assigned silos. The GMP is computed from the estimated current basic unit production cost and allowable profit margin. The contracting cost considers the GMP, market location, source of grains, and receiving silos. The LBAs do not always meet the supply orders due to issues such as scarcity and increasing cost of procurement.

Food releases are done either for price stabilization or emergency purposes on the approval of the Presidency. Released food commodities are conveyed by registered contractors sponsored by the beneficiary or government as may be necessary. Stabilization releases are primarily made to the public in such a manner that the releases protect consumers and processors against price hikes. As a matter of policy, grains that have attained the maximum storage period of three years are usually released to individuals and companies based on the approval of the Honourable Minister and recommendation from the Department. In some cases, the distribution of released food commodities during emergencies and disasters is carried out by NEMA which has the statutory mandate.

The strategic reserve program is implemented through the Federal Government silo facilities constructed across the country (see summary in Table 2). However, while the official policy is to locate the silos in grain cultivation areas, political considerations may have influenced the location of some of the silos.

The stocks are replenished through emergency and or regular procurements. During emergency procurement, suppliers are selected based on previous records of performance to urgently supply stock at the approved price, not necessarily the GMP. At the end of the exercise, the records of the transactions are then forwarded to the Bureau of Public Procurement in line with the provision of the Public Procurement Act 2007 to formalise the procurement process.

The Regular Procurement is currently through LBAs and the procurement prices are based on approved GMP. The selection of LBAs is based on a shortlist established through verification of stock availability and capability of suppliers, who in addition, meet the requirements of the Procurement Act. Subsequently, their submissions are evaluated by the Tenders Board Secretariat and forwarded to the Tenders Board for consideration and award.

The Food and Strategic Reserve has managed the grain stock well within the limits of its resources. This is achieved through good quality control practices of receiving and management of grains in storage. Grain stock in a silo is a very huge investment (at the current GMP of $416/MT, it will cost $10,400,000 to stock a silo complex of 25,000MT). Mismanagement will result in the deterioration of grains, translating to colossal loss in investment, wastage in stock and reduced availability. In addition, FSRD has stepped up the monitoring of the stock in storage to guide and improve the security of the stock with the pilot installation of close circuit cameras and real-time weighing-in/-out at the silo complexes at Yola, Ilesha, Minna and Dutsinma. High solar-powered security lights have also been installed in all the FGN retained Silo Complexes. A successful

food transfer is based on good quality grains and safe food release. Similarly, availability will further diminish, if the grains are not properly documented or monitored/secured against pilferage

Gaps and Weaknesses

i). Some of the silo complexes are currently facing technical (structural and machinery) challenges due to the ageing and obsolescence of some equipment, and non-strict routine and preventive maintenance occasioned by the scarcity of funds.

ii). The laboratories are not adequately equipped to carry out advanced and complex food analyses like mycotoxin analysis as well as a series of food analyses to establish its safe consumption for human and animal consumption.

iii). The government's intervention in price stabilization is not very impactful due to its limited scope both in terms of funds and quantity of stored grains. Based on the total supply in 2021 and regarding the 5% grains considered in this report, the government held holding less than 0.4% while over 99.6% is being held by grain traders and merchants.

iv). The state governments lack the political will to pull through the Buffer Stock Scheme for price stabilization and serve as the second level of the National Food Security Program. This may also be due to a lack of initial (capital) investment by the state governments.

v). There is little synergy among government institutions that are charged with data generation and management. Accessibility to up-to-date data on food grains production, market prices, weather report and others, becomes a bit cumbersome.

vi). ECOWAS protocol of keeping both physical and financial stocks demands a strong political will and discipline to create and maintain a budgetary provision for the financial stock. Nigeria presently keeps only physical stock.

vii). The mechanism for stocking the silos through the Guaranteed Minimum Price is weak and subject to abuse. There is a need to rejuvenate the system, from the composition of the National Committee on GMP, its operations, the time of announcement of the GMP, and the profit allowance(s) made for the suppliers.

viii). Presently, there is no distinction between food aid (emergency) stock and price stabilization stock, hence it becomes difficult for the government to recoup a substantial part of the cost of stocking and management of the food grains meant for the stabilization program.

3.4 Physical Capacity and Infrastructure of the Food Reserves in Nigeria

The Federal Government of Nigeria through the FSRD has a combined total storage capacity of 1,336,000 MT when fully utilized as shown in Table 2. However, given the need to optimally utilize the excess silo capacity, and the need to involve the private sector in the management of the silo programme, the government decided to concession some of the silo complexes, thus ensuring full capacity utilization of silos facilities and generation of revenue to the government.

Gaps and Weaknesses

i. Some of the silo projects are still under construction and have overrun their initial contract time and cost.

Table 2: Current distribution and locations of Strategic Food Reserves Silos in Nigeria on Ge-o-political a Zonal basis

Geo-Political Zones	Concessioned silo (MT)	FGN Retained Silo (MT)	Completed & Yet to be either concessional or operational (MT)	Silos With Challenges (MT)	Total Capacity (MT)
North-Central	161,000	50,000	25,000	0	236,000
North-East	25,000	25,000	50,000	175,000	275,000
North-West	200,000	125,000	0	0	325,000
South-East	50,000	0	0	100,000	150,000
South-South	25,000	25,000	0	125,000	150,000
South-West	175,000	25,000	0	0	200,000
TOTAL	**636,000**	**225,000**	**75,000**	**400,000**	**1,336,000**

Source: FSRD FMARD, 2022

ii. Some of the equipments are obsolete and this impacts the operational efficiency of the system.

iii. Some of the completed silos have challenges: the one at Ilesa was forcefully entered during a civil disturbance resulting in the vandalization of some equipment; the newly completed silo complex at Bauchi has been partly destroyed by a windstorm.

iv. Some silo projects are affected by environmental and natural issues such as ravine encroachment, erosion and windstorm damage.

3.5 Performance of the Food and Strategic Reserve in Nigeria

The Food and Strategic Reserve scheme has performed well since its establishment. It has been able to keep a reasonable quantity of reserve despite several challenges which range from budgetary constraints, institutional issues, staff capacity, harsh conditions within which the staff of the silo operates etc. The current stock as of May 2022 is 100,000 MT.

Figure 9 presented below shows that there have been intermittent stocking and de-stocking of food commodities during the period under review. These activities have not been as regular as expected due to scarcity of funds, lack of enough grains to procure (as a result of low production), or the avoidance of government to procure in order not to exert further pressure on the market. It shows the emergency release in 2020 during the COVID-19 period and the releases to vulnerable groups affected by floods, violent insurgency, and the IDPs in various camps, this was highest in the 2012/2022 periods.

3.6 Nigeria Road Network for Food Production and Distribution

The silo sites nationwide as shown in Figure 10 are strategically linked to the four (4) major Trunk A roads to facilitate the movement of food commodities from the farm to the silo facilities. The secondary roads from States and Agricultural areas are also directly linked to the Trunk A road.

However, the poor condition of the secondary roads linking the farms to the markets, where the grains are aggregated and to the silo facilities, makes the transportation cost very exorbitant. This is greatly affecting the cost-effectiveness of food reserves. The ongoing efforts of the Federal Government to improve infrastructure nationwide most especially major and secondary roads and the attempt to link major cities by railway is expected to address these challenges.

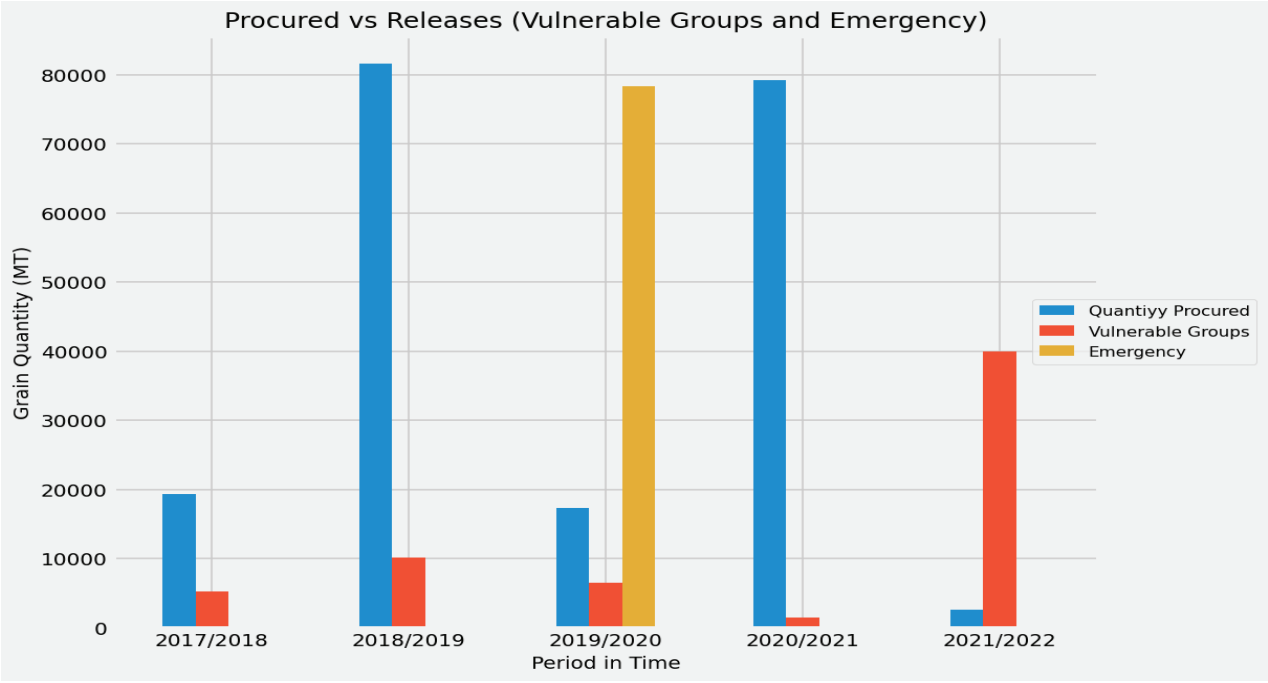


Figure 9: Procurement and Releases for Emergency and Vulnerable Groups.
Source: FSRD FMARD, 2022

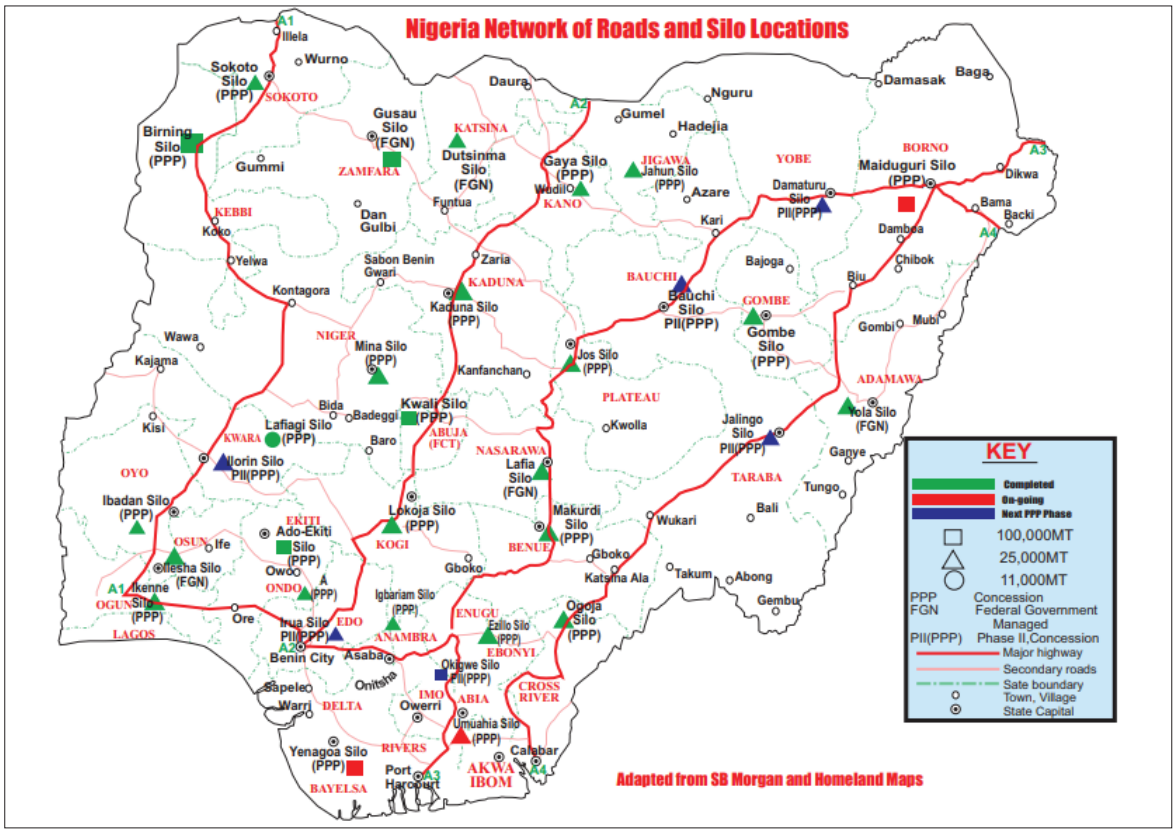


Figure 10: Nigeria Road Network and Silo Locations

Source: SB Morgan and Homeland Maps

Gaps and Weaknesses

i. The silo sites are not linked by the railway system, thus limiting the transportation of grain by road, which is expensive due to the high cost of fuel as well as the total overhead cost.

ii. Most of the roads linking the Trunk A roads from the farm to the aggregation centres and the silo facilities are in a bad state, thus increasing the transport cost and unduly increasing the turnaround time of grain delivery to the silos.

3.7 Seasonal Crop Calendar for the Country and the West African Region

The Seasonal Crop Calendar for the country and the region is also relevant in guiding the FSRD in the appropriate time to intervene either for stocking or releases. The mandate crops/food items for FSRD presently are maize, paddy rice, sorghum, millet, soybean, gari and most recently cowpea.

Cropping seasons for the seven major crops considered in this study are presented in Figure 11. There is variation in the cropping seasons of the respective crops between the North and the South of the country. The country is segmented into six distinct agroecological zones from the South-North direction starting from the Atlantic coast to the arid savannah of Sahel. These are as follows: Mangrove Swamp, Rainforest, Derived Savanna, Guinea Savannah, Sudan Savannah and Sahel Savanna zones. Every zone has peculiar kinds of crops that are easily adapted to it. Figure 11 shows that maize is harvested from September to October for the first maize in the Southern and Northern parts of the country while the second harvest for maize is from early December to January, hence the right time for FSRD to intervene and procure maize should be around this period when there is surplus.

Furthermore, millet and sorghum are harvested in the North during the period from October to December, therefore, this is the appropriate time to intervene and procure the food grains. Soybean is harvested in the North from October to November, while the harvesting is done from August to October in the South. In view of the importance of *garri* in Nigerian food security, cassava which is the main raw material is the only crop that is not food grain among the mandate

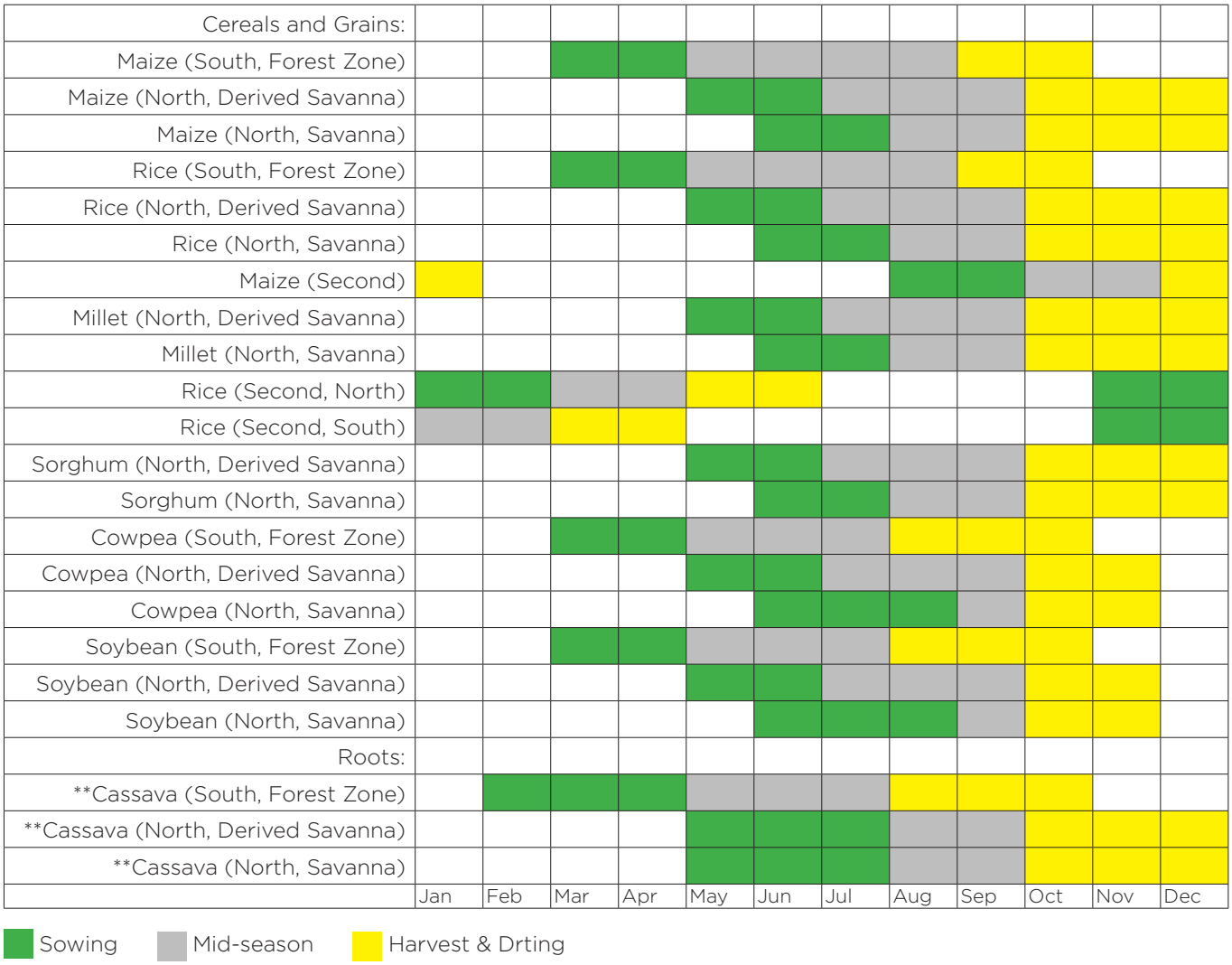


Figure 11: Crop Calendar.

Source: NAERLS/Production Estimates and Crop Assessment Division (ECAD), USAID

crops. Its best harvest period is September and November at the end of the rainy season when the starch content is highest if a starch processing factory is targeted, while the period between February and April at the beginning of the rainy season is best for harvest for the lowest starch content most ideal for *garri* processing.

While in the case of paddy rice, soybean, and cowpea the most appropriate time for procurement and release can be determined from Figure 11. The price soars during the lean period which is seven months after the harvest of the annual crops, but the price will drastically during harvest naturally as presented in Figure 11.

The majority of countries bordering Nigeria harvest their grains towards the end of the year, as presented in Figure 12. Most of these countries harvest between September and December, about the same period grains are harvested in Nigeria. There is also a similarity in the planting season which is from the early part of the year to mid-year. It can be deduced from these patterns that low and high grain price periods are the same across many West African countries. Also, the similarity in the harvesting and planting periods is a factor in the high volume of informal inter-border trade between Nigeria and the neighbouring countries.

Figure 13 shows the price trends for cowpeas, maize, millet and sorghum in the Dawanau market in Kano, Kano State with low prices towards the end of the year in the harvest period and high prices in June and July during planting season.

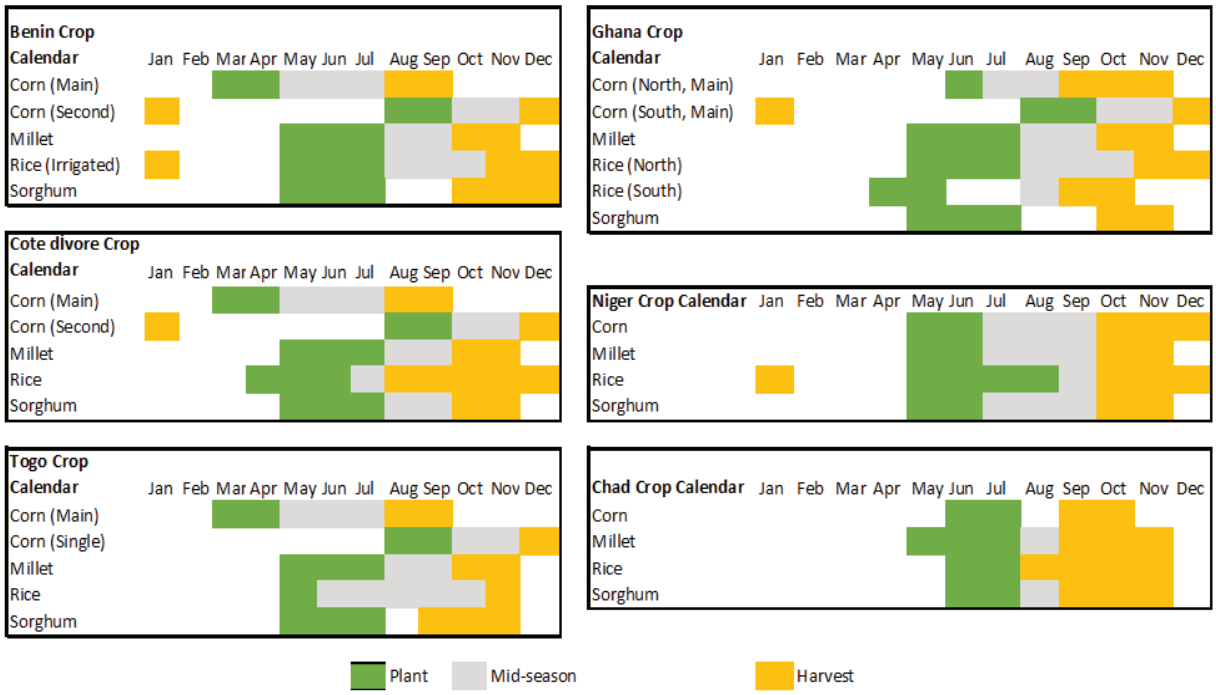


Figure 12: Crop Calendar for some West African countries.

Source: West Africa - Crop Calendar (usda.gov)

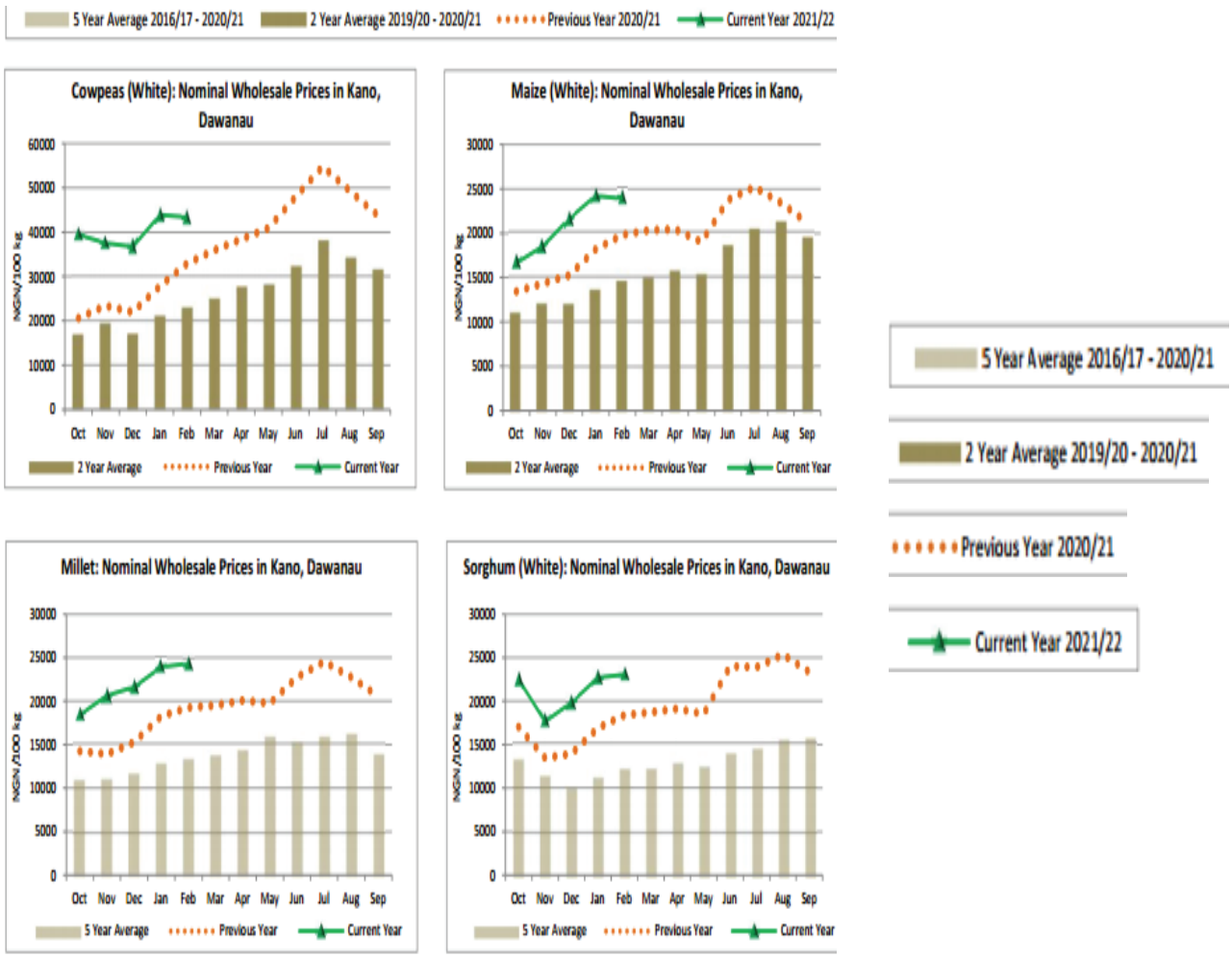


Figure 13: Prices of some of the Mandate Crop in Dawanu market, Nigeria from 2016-2021.

Source: FEWNETS, 2022

The behaviours of the price trends of rice, maize, sorghum, millet, and soybean in the Northern States of Adamawa and Nasarawa are shown in Figure 14. Low prices were recorded towards the end of the year from September to December which is the harvest/drying period, but high prices were recorded in March/April and August/ September. Note that price is also a function of production, yield, demand and supply among other factors and not of harvest only.

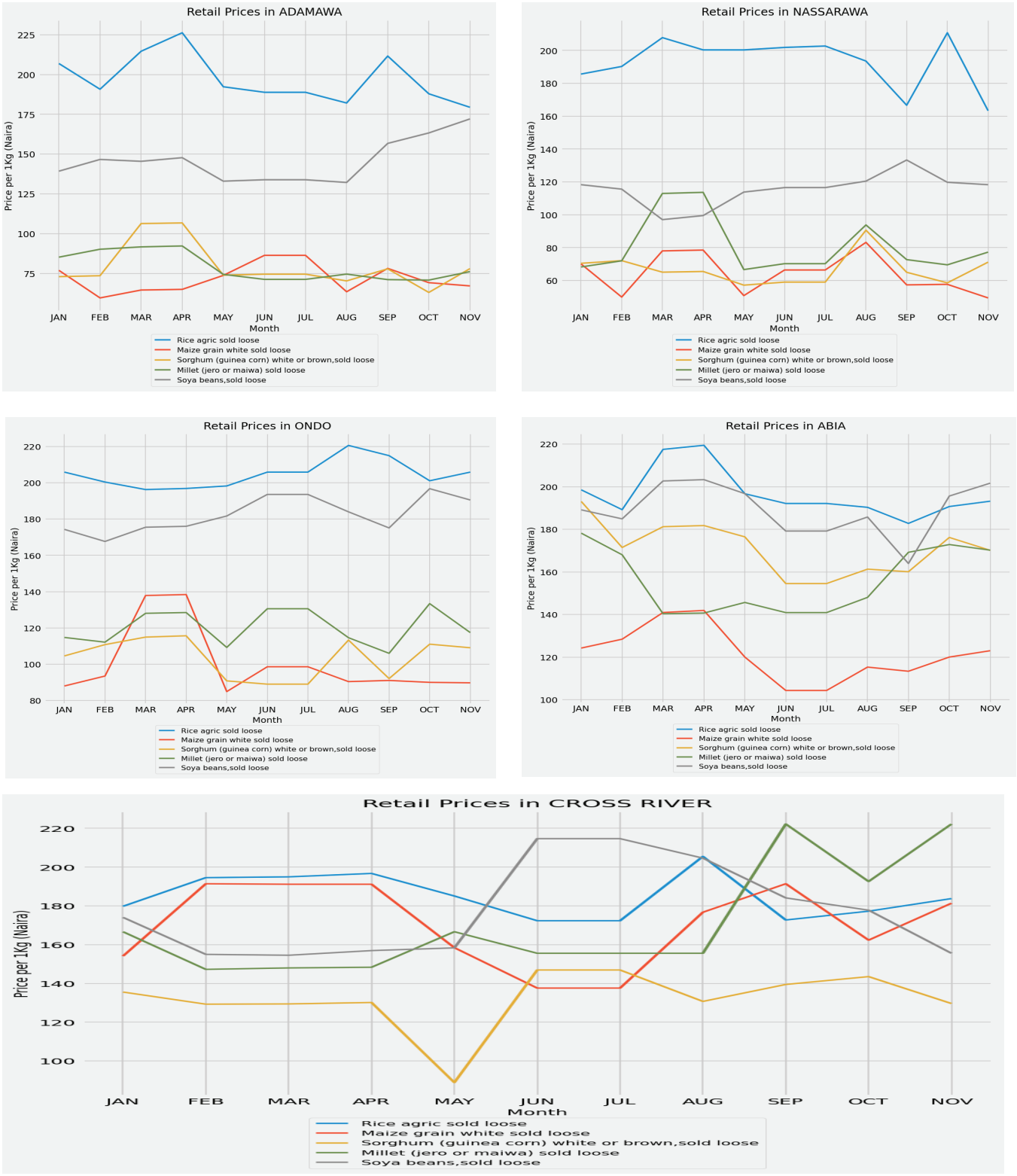


Figure 14: Price trends of rice, maize, sorghum, millet, and soybean in some States (Adamawa, Nasarawa, Ondo, Abia, and Cross River)
Source: National Bureau of Statistic Retail Prices Survey 2015

Also, Figure 14 shows price trends of rice, maize, sorghum, millet, and soybean in the Southern States of Ondo, Abia, and Cross River. Low prices were recorded towards the end of the year from September to December which is the harvest/drying period, but high prices were recorded in March/April and September/October to November. The two planting periods in the South are March to April and July to August. However, any exception in the behaviours of the price trends is to show that price is also a function of production, yield, demand and supply among other factors and not of harvest only. Generally, the FSRD can leverage this seasonal grain production and prices to optimize the areas of interventions in stabilizing prices, ensuring all times food supplies and food security and also guaranteeing returns to the food chain actors in the county.

Gaps and Weaknesses

In some cases, procurement of food commodities by FSRD is not timely and is not aligned with the trends in Seasonal Crop Calendar for effective and efficient management and operations of the Reserve. The procurement cycle takes an average of three to six months and even when the timing is right, the budgetary release (availability of funds) may not coincide with either timing or planned fund release. However, because of the critical nature of the activities that need to be implemented when the fund is provided, the government should treat fund releases to the FSRD as urgent and essential.

4 Determining the Optimal Sustainable Capacity and Stocks for the SFR

4.1 Background

This section focuses on the determination of the optimal quantity of food commodities for the reserves under two storage policy regimes: buffer stocks and emergency or strategic reserves. The first storage policy regime is a strategic reserve for emergencies exclusively which aims at ensuring food supply for the most vulnerable populations during periods of food shortage or price hikes. The purpose of the strategic reserve is to overcome food supply shortfalls caused by climate and weather-related shocks (such as droughts or floods), pests, and political instability (Lynton-Evans, 1997). Additional food is brought via targeted food subsidies (e.g., food stamps, food for work, school feeding programs, etc.) during a crisis (Kornher and Kalkuhl, 2014).

The second storage policy regime is a buffer stock strategy also called a price stabilization reserve which aims at stabilizing farm gate and consumer prices by always buying and selling grains. When food prices exceed a predetermined ceiling, additional supply is released on the market whereas, on the other hand, governments act as a buyer of last resort whenever prices are low (Kalkuhl et al., 2016).

We present a general framework to design a cost-effective reserve policy which will address price stability and food security for the vulnerable Nigerian population. Both physical and virtual reserves are considered potentially effective measures to cope with price and supply shocks.

4.2 Defining Optimal Stocks

According to Goletti et al., (1991), the optimal level of public food grain stock is defined as the level of stock that ensures a certain degree of price stabilization and a certain amount of food grain supply through the rationing system and for the food-for-work operations, vulnerable group development, and other relief programs at minimum cost. Keeping an optimal stock is about making provisions to meet demand without keeping excess and without having stock outs or shortfalls.

Annual production is subject to great fluctuation and consequently not sufficient to meet stable consumption needs in non-exporting economies. Food imports and stocks can offset these production fluctuations; however, to be secured, a stock should be kept for stabilizing supplies through the worst series of shortfalls.

4.3 Estimating the Vulnerable Population in Nigeria

The estimation of the population of vulnerable groups by Fiche Nigeria (2021) is shown in Table 3 (current situation, March and May 2022) and Table Table 4 (projected situation, June - August 2022).

Incessant incidences of banditry and kidnapping were experienced predominantly in Kaduna, Katsina, Niger, Sokoto and Zamfara States, while the farmers-herders conflict was reported in Benue State. All these civil insecurities have continued to induce displacement, livelihood depletion and limited access to farmlands in these areas. Pockets of attacks by Non-State Armed Group (NSAG) in the North-eastern States of Adamawa, Borno and Yobe impact negatively on livelihoods and food and nutrition status of households. Flooding was reported in some states (Jigawa, Kebbi, Bauchi, Benue, Niger, Yobe, Edo, Cross-River and FCT), which destroyed thousands of hectares of cereal crops. This has negatively impacted food availability, leading to reduced food stocks at the household level.

Summarily, the results in Table 4 indicate that between March to May 2022 about 14,455,049 Nigerians were in a critical acute food insecurity state (Phases 3 and 4) and require urgent attention. Therefore, 9% of the Nigerian population are vulnerable and food insecure; and the FSRD needs to consider them in its programme.

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Table 3: Estimation of Population Per Phase of Food and Nutrition Insecurity in the Current Situation - March to May 2022

State	Total Population	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total Phase 3-5
Abia	4 945 534	2 807 281	1 552 752	585 500	-	-	585 500
Adamawa	5 125 061	2 482 969	1 852 318	787 598	2 177	-	789 774
Bauchi	7 683 291	6 192 256	1 204 045	286 991	-	-	286 991
Benue	6 516 727	5 365 863	781 064	369 800	-	-	369 800
Borno	6 309 889	2 958 984	1 920 917	1 262 216	167 772	-	1 429 988
Cross River	4 774 819	3 949 936	579 044	245 839	-	-	245 839
Edo	4 800 000	3 478 697	1 042 828	278 475	-	-	278 475
Enugu	5 213 985	3 262 890	1 659 524	291 571	-	-	291 571
FCT	4 563 988	3 359 674	855 828	348 486	-	-	348 486
Gombe	3 545 032	2 920 810	436 187	188 035	-	-	188 035
Jigawa	6 943 384	5 539 312	955 730	448 342	-	-	448 342
Kaduna	9 667 996	6 873 462	1 880 113	914 421	-	-	914 421
Katsina	9 094 681	6 113 254	1 780 521	1 081 131	119 775	-	1 200 906
Kano	15 429 060	11 440 902	3 378 609	609 548	-	-	609 548
Kebbi	5 069 761	3 577 657	1 023 054	469 050	-	-	469 050
Lagos	28 154 342	22 249 931	4 124 217	1 780 194	-	-	1 780 194
Niger	6 533 450	4 063 122	1 881 265	589 063	-	-	589 063
Sokoto	5 910 614	3 271 479	1 611 489	1 004 206	23 440	-	1 027 646
Plateau	4 798 018	3 569 642	863 697	364 679	-	-	364 679
Taraba	3 570 308	2 750 680	574 135	245 493	-	-	245 493
Yobe	4 614 209	2 355 063	1 363 803	825 388	69 955	-	895 343
Zamfara	5 245 125	2 836 644	1 697 991	710 490	-	-	710 490
Total General	**158 509 275**	**111 420 507**	**33 019 133**	**13 686 516**	**383 119**	-	**14 069 635**
IDPs-Sokoto	56 593	13 016	19 808	18 110	5 659	-	23 769
IDPs-Benue	357 473	7 149	42 897	150 139	157 288	-	307 427
IDPs-Zamfara	142 680	45 658	42 804	39 950	14 268	-	54 218
IDPs	**556 746**	**65 823**	**105 508**	**208 199**	**177 215**	-	**385 414**
Total-General + IDPs	**159 066 021**	**111 486 331**	**33 124 641**	**13 894 715**	**560 334**	-	**14 455 049**

Source: Cadre Harmonisé Result for Identification of Risk Areas and Vulnerable Populations in Twenty (20) Nigerian States and the Federal Capital Territory (FCT) of Nigeria. fiche-nigeria_mar_2022_ final _reviewed.pdf (fscluster.org). Colour code: Green (Minimal); Yellow (Stressed); Orange (Crisis); Red (Emergency); Wine (Famine)

In the projected period of June – August 2022, about 19,453,305 people (12.3% of the population) were classified under the combined critical (crisis and emergency) phases of food and nutrition insecurity in the 20 states and the FCT (Table 34). This indicates an increase of over three percentage points in the number of the vulnerable population between the two periods.

4.4 Selection of Appropriate Model

Price volatility is a common feature of agricultural markets (Von Braun and Torero, 2009). The steep rise in food prices triggered by a set of complex factors including the Russia-Ukraine Conflict, the COVID-19 pandemic, climate shocks, and policy and market failures are affecting the economies of many countries. To address these problems and especially their effects on livelihoods, the implementation of a physical food reserve to facilitate a smooth response to food emergencies combined with the setting up of a virtual reserve to keep prices at reasonable long-run market levels are crucial (Von Braun and Torero, 2008 and 2009).

This innovative mechanism avoids the need for expensive storage costs and the poor management of stocks. However, the key challenge would be to develop a governance structure that would clearly define trigger mechanisms to determine when to release stocks to calm markets in times of stress (Torero, 2016). Such mechanisms are a necessary condition for the strategic food reserve to operate as a tool that addresses extreme price volatility.

FSRD is expected to release grains to cushion the effect of high prices at appropriate times to ensure a continuous food supply and therefore to stabilize food prices. The impact of this policy may have been limited because of the low level of stocks resulting from limited financial resources. The quantity of stocks (100,000 MT) held by FSRD in the year 2021 is less than 0.4% (Table 5) of the total grain supply (28,614,000 MT) of maize, rice, millet, sorghum and soybeans in the year 2021, leaving over 99.6% of grain stocks in the hands of private sectors whose activities determine availability and accessibility of grains in the markets.

Table 4: Estimation of Population Per Phase of Food and Nutrition Insecurity in the Projected Situation (June to August 2022)

State	Total Population	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Total Phase 3-5
Abia	4 945 534	2 338 756	1 874 021	732 757	-	-	732 757
Adamawa	5 125 061	1 910 973	2 205 512	1 002 047	6 530	-	1 008 576
Bauchi	7 683 291	5 693 060	1 537 090	453 141	-	-	453 141
Benue	6 516 727	4 498 083	1 472 047	546 597	-	-	546 597
Borno	6 309 889	2 230 474	2 144 339	1 569 348	365 728	-	1 935 076
Cross River	4 774 819	3 433 587	1 012 435	328 797	-	-	328 797
Edo	4 800 000	3 340 101	1 138 828	321 071	-	-	321 071
Enugu	5 213 985	3 778 539	1 251 356	184 090	-	-	184 090
FCT	4 563 988	3 031 356	925 172	607 461	-	-	607 461
Gombe	3 545 032	2 482 726	759 266	303 039	-	-	303 039
Jigawa	6 943 384	5 237 736	1 161 589	544 060	-	-	544 060
Kaduna	9 667 996	5 165 321	3 072 756	1 429 919	-	-	1 429 919
Katsina	9 094 681	5 274 537	2 169 940	1 440 125	210 079	-	1 650 204
Kano	15 429 060	10 903 393	3 740 289	785 378	-	-	785 378
Kebbi	5 069 761	3 241 120	1 173 804	654 837	-	-	654 837
Lagos	28 154 342	19 704 947	5 840 539	2 608 856	-	-	2 608 856
Niger	6 533 450	3 710 711	2 124 330	677 928	20 482	-	698 409
Sokoto	5 910 614	2 770 782	1 870 554	1 122 418	146 860	-	1 269 278
Plateau	4 798 018	3 236 208	1 026 810	535 000	-	-	535 000
Taraba	3 570 308	2 634 622	643 327	292 359	-	-	292 359
Yobe	4 614 209	1 932 616	1 481 877	984 018	215 698	-	1 199 716
Zamfara	5 245 125	2 249 645	2 046 746	934 422	14 312	-	948 733
Total- General	**158 509 275**	**98 799 293**	**40 672 628**	**18 057 667**	**979 687**	-	**19 037 355**
IDPs- Sokoto	56 593	6 791	22 637	19 808	7 357	-	27 165
IDPs- Benue	357 473	-	35 747	153 713	168 012	-	321 726
IDPs- Zamfara	142 680	21 402	54 218	45 658	21 402	-	67 060
IDPs	**556 746**	**28 193**	**112 603**	**219 179**	**196 771**	-	**415 950**
Total-General +IDPs	**158 784 429**	**98 827 486**	**40 785 231**	**18 276 846**	**1 176 459**	-	**19 453 305**

Source: Cadre Harmonisé Result for Identification of Risk Areas and Vulnerable Populations in Twenty (20) Nigerian States and the Federal Capital Territory (FCT) of Nigeria. fiche-nigeria_mar_2022_ final _reviewed.pdf (fscluster.org) Colour code: Green (Minimal); Yellow Stressed); Orange (Crisis); Red (Emergency); Wine (Famine)

.Table 5: FSRD Stocks versus Total Supply of Maize, Rice, Millet, Sorghum and Soybean

FSRD Stock in 2021	Total Supply in 2019 (FAOSTAT)	Total Supply in 2021 (USDA)
100,000 MT	28,569,000 MT	28,614,000 MT
FSRD Stock % of FAOSTAT/USDA	0.35	0.35

Source: Author, 2022

A review of the relevant literature reveals three relevant models used for the determination of optimal stock of stabilization reserve; however, two apply to this assignment. The first model, applied by Goletti, F et al. (1991) in a study conducted in Bangladesh was not adapted for this study. This is because of the heavy public presence in food reserves in Bangladesh, relative to Nigeria, where the private sector overshadows the public sector in grain management. Nigeria runs a free-market economy and therefore, a model that was designed for a controlled market like Bangladesh cannot be adapted to an open market.

The second model, which is considered best suited for the estimation of optimal stocks for Nigeria's reserve was adopted from the study carried out for ECOWAS (see Kornher, L. and Kalkuhl, M. 2014). In arriving at the optimal stocks of the regional reserve, the study first estimated the optimal stocks of member states, which makes the model attractive.

The third model, which uses a two-objective linear programming approach to formulate and optimize the size of total-grains buffer stock, is also considered appropriate in this study because of its root in a free-market economy (Eaton, D. J. 1980). The model is contained in the system analysis of grain reserve conducted in the International Economics Division; Economics, Statistics, and Cooperatives Service; U.S. Department of Agriculture.

4.5 Computational Procedures for Determining Optimal Stocks and Optimal Capacity

A. Optimal Stocks

According to Kornher and Kalkuhl (2014), consumption at year *t*, X_t, can be estimated as:

$$X_t = PD_t + IM_t - EX_t \quad \text{..... (1)}$$

where PD_t is production, IM_t is imports, EX_t is exports and *t*, represents the year. In the FAOSTAT data (2010-2019) used in this assignment, production, import, export and domestic supply amongst others, were reported. According to equation (1), after taking care of exports, **everything supplied through production and imports was assumed to have been consumed.**

Other assumptions are that leakages through borders (illegal exports or smuggling of grains), distortions from hoarding and wastages are negligible. Production, import and export data trends are found in Annex 17 and Annex 20.

The second school of thought favours the computation of consumption figures using per capita consumption (kg/person/year) as:

$$X_t = PP_t * PCC_t \quad \text{.....(2)}$$

where PP_t is the population at year *t*, and PCC_t is per capita consumption at year *t*.

Actual supply is estimated as:

$$TS_t = DS_t + IM_t \quad \text{..... (3)}$$

where TS_t is actual supply and DS_t is domestic supply at year *t,* (PD_t and DS_t are distinctively captured in FAOSTAT data).

It is expected that when production falls short of the **desired level of minimum consumption**, additional imports should offset the shortfalls. Despite the imports, food availability still varies drastically from year to year and the offset of shortfalls by imports becomes unrealizable due to large fluctuations in the international prices that make food import bills unpredictable (Sarris et al. 2011). This makes optimal stocks very pertinent in countries like Nigeria. Optimal stock is about the shortfall, which is the difference between the target supply and the actual supply.

The desired level of minimum consumption is usually a percentage of the long-term consumption trend and is referred to as the target consumption level, X_t^*. Percentages of consumption such as 99%, 97%, 95%, 90%, 88%, 84%, and 78% have been reported.

Whenever the actual national supply (TS_t) is lower than the target consumption level (X_t^*), then optimal stocks are used to close the gap between actual supply (TS_t) and the desired consumption (X_t^*).

If the target consumption level is to be satisfied, the same amount has to be supplied. Logically then, the target consumption level (X_t^*), is also referred to as the target supply. The difference between target supply and actual supply, at any time period *t*, is the shortfall at the time period *t*. Over a long-term period, a trend of shortfalls is obtained as a list given by:

$$[\, X_t^* - TS_t] \quad \text{.....(4)}$$

and the maximum of the trend is given by:

$$S^* = max[X_t^* - TS_t] \quad \text{.....(5)}$$

Optimization is about minimizing or maximizing a function. The function, $max[X_t^* - TS_t]$ in (5) returns S^*, the maximum value or the largest historic shortfall over the time period t_1 to t_n is a percentage of X_t earlier estimated using (1). This is the quantity that must be stocked, and it is the minimum required for a safe level of food security. That is, in optimal stock estimation, consideration is given to the worse-case supply deficit. In optimal reserve, this gives the optimal stock for the grain under consideration. The same procedures are applied to other grains. The time t_1 is 2010 and t_n is 2019. The food balance of Nigeria in FAOSTAT was not more than the year 2019 at the time of this study.

B. Emergency Reserve

In an emergency, normal supply falls short of the desired minimum consumption and emergency reserve steps in to lift consumption to the desired minimum level (Kornher, L. and Kalkuhl, M, 2014). In a worst-case scenario, all forms of supply are completely disrupted and the reserve is the only option left to provide a lifeline. In such a situation, the reserve must make available the desired minimum consumption level of food grain. This means the reserve must contain the right quantity of the food grain and that quantity is provided by the history of consumption over a period of time. The consumption value of interest is the highest for a food grain within a period of time. That is, to be on the safest side, provision should be made for the highest consumption value ever experienced within the period under consideration since the event that led to that experience might still be repeated. Therefore, the emergency reserve has to make available the total target minimum consumption of all the grains which is given by:

$$sc^* = \sum_{i=1}^{5} = SC_i^* = \sum_{i=1}^{5} max_t[X_{i|t}^*] \quad \text{.....(6)}$$

The function, $\sum_{i=1}^{5} max_t[X^*_{i|t}]$ gives optimal capacity (SC^*), which is the summation of the highest target consumption of all grains. "t" indexes years (2010 to 2019) while "i" indexes the different crops under study (maize, milled rice, millet, sorghum and soybeans).

C. Buffer Stocks (Stabilization Reserve)

In Buffer Stocks (Stabilization Reserve), "Storage" is about year-to-year carryover and there is the presumption that distribution of the product among years is a serious problem, whereas distribution within a year, given the total amount to be utilized within the year, is relatively trivial from a policy viewpoint (Gustafson, Robert L. 1958). The total available supply (TS_t) in any year, *t*, is the quantity available for utilization (X_t) and carryover (X_{t-1}) from the previous year, t-1.

$$TS_t = S_{t-1} + X_t \quad \text{.....(7)}$$

A "rule of storage," is simply a function (θ_t) which explicitly states the way in which S_t, ending stocks in year *t*, depends on S_{t-1} and X_t;

that is:

$$St = \theta_t (S_{t-1}, X_t) \quad \text{.....(8)}$$

Stocks are part of national supply and demand. In each year a constant portion (γ) of the total available supply (TS_t), which is a linear approximation of Gustafson's pioneering stocking rule, is stocked in (Kornher, L. and Kalkuhl, M. 2014). In this way, stocks change over time.

Then, (8) can be further expressed as

$$S_t = \gamma(S_{t-1} + X_t) \quad \text{.....(9)}$$

and for future stocks,

$$S_t + 1 = \gamma(S_t + X_{t+1}) \quad \text{..... (10)}$$

S_t are opening stocks available for consumption in year *t* and S_{t+1} are the stocks carried to the next year, (t+1). γ is the constant portion of the total available supply (TS_t) that is carried to the next year, (*t*+1).

Then substituting (1), $X_t = PD_t + IM_t - EX_t$ (stocks added in year, *t*) in (9) and adding the normally distributed error term (ε_i), (9) becomes

$$S_{i|t} = \gamma_i (S_{i|t}\text{-}1 + PD_{i|t} + IM_{i|t} - EX_{i|t}) + \varepsilon_i \quad \text{.....(11)}$$

The optimal stocking rule under national stockholding can be estimated using actual stock data (USDA stock data). The stocking parameter (γ_i) can be obtained by estimating equation (11) with the ordinary least squares method.

$$S_t^* = \frac{\gamma(X^*)}{(1-\gamma)} \quad \text{.....(12)}$$

where S_t^* is the optimal stock level and X* is the target consumption at year *t*.

$$\alpha^* = \frac{\gamma}{(1-\gamma)} \quad \text{.....(13)}$$

where α* the corresponding optimal stock-to-use ratio. The stocks-to-use ratio is the ratio of market-year ending stock over total demand usage.

D. Optimal Capacity of Buffer Stock

The two-objective model for estimating the optimal capacity of buffer stock is designed to minimize the necessary storage while maximizing food security subject to constraints (15) to (19).

These constraints are:

i. (15) end-year stock of year *t* plus grain utilised in year minus beginning-year stock of year *t* must be equal to expected demand (production plus import) of year *t*;

ii. (16) end-year stock of year *t* cannot be greater than the available storage space C;

iii. (17) that the fraction of expected demand that is actually utilized will always be maintained greater than or equal to a lower bound. $A_t * PI_t$ is utilization, PI_t is production plus import and A_t is a fraction of the expected demand that is actually utilized. Import is not relevant for a country that is self-sufficient in grain production.

iv. (18) values of the variables (S_t, A_t, PI_t, B, C) involved can be greater than or equal to zeros; and

v. (19) takes values of 1, 2, 3,.. n corresponding to 2010, 2011, 2012, ..., 2021.

Food security is a measure of how the stock functions to stabilize supplies over *n* years. The level of food security within the years of interest is the lowest fraction of expected demand (production plus imports) which the system has the capacity to supply over n years. That lowest fraction is defined as B. These stated objectives require that C be minimized and B be maximized simultaneously.

The two-objective formulation is as follows:

Maximize [B, -C] .....(14)

Subject to:

$S_t - S_{t-1} + A_t * PI_t = PI_t$.....(15)

$S_t - C \leq 0$ .....(16)

$A_t - B \geq 0$ .....(17)

$S_t, A_t, PI_t, B, C \geq 0$ .....(18)

t = 1,2,.....,n .....(19)

where S_t is end stock in year *t* and cannot be greater than the available capacity C, S_{t-1} is end stock in year *t*, A_t is the sum of production and imports added in year *t*, *n* is a fraction of expected demand at year and must be greater than B, and $A_t * PI_t$ is utilization (quantity consumed) in year *t*. *n* is 12 (1 – 12 corresponds to 2010 – 2021).

The expected demand level for grains in any year is assumed to be deterministic, and equal to the expected volume of production (Eaton, D. J. 1980), and by extension, equal to the expected volume of production plus imports in countries that import food grains.

4.6 Findings and Results

4.6.1 Results Computed using Consumption Figures Estimated from Production, Import and Export Figures (equation 1 in section 3.4)

The use of production, import and export figures to estimate consumption figures, brings out variations which are consequences of various events that occurred during a period under consideration, in expected consumption figures over the period. However, there is a possibility of underestimation of a country's expected consumption figures because of the low production of grains and/or lack of financial capability to import enough food grains into a country. Further on this is the fact that underestimation of consumption figures is most likely not going to be an issue as far as Nigeria is concerned because there is the availability of food grains but accessibility is below expectation due to high food grains prices (annual consumer prices inflation is 16.95% according to World Bank database 2022) which are partly an outcome of high transportation fares.

In Figure 15, maize consumption fluctuated upwards but had its peak at 11,719 (1000MT) in 2016. It came down to 11,048 (1000MT) in 2017, then remained at an average of 11,170 (000MT). Rice consumption rose from 7,230 (1000MT) in 2010 to 8,370 (1000MT) in 2014 and came down to 7,477 (1000MT) in 2015; picked up and continued rising until it hit 8,448 (1000MT) in 2019. After 2014, the difference between rice and maize consumption became wide, with maize higher by more than 2,000 (1000MT). This may be partly a result of the high price of rice in markets. Rice is available, but its accessibility has been reducing in the last few years.

Millet consumption declined from 5,118 (1000MT) in 2010 to 901 (1000MT) in 2013, then rose to 2,098 (1000MT) in 2018 and dropped to 1,980 (1000MT) in 2019. Sorghum consumption declined from 7,082 (1000MT) in 2010 to 5,261 (1000MT) in 2013. It rose to 7,476 (1000MT) in 2016 and maintained an average of 6,732 (1000MT). Soybean consumption fluctuated upward from 350(1000MT) in 2010 to 988 (1000MT) in 2016 and dropped to 575 (1000MT) in 2019.

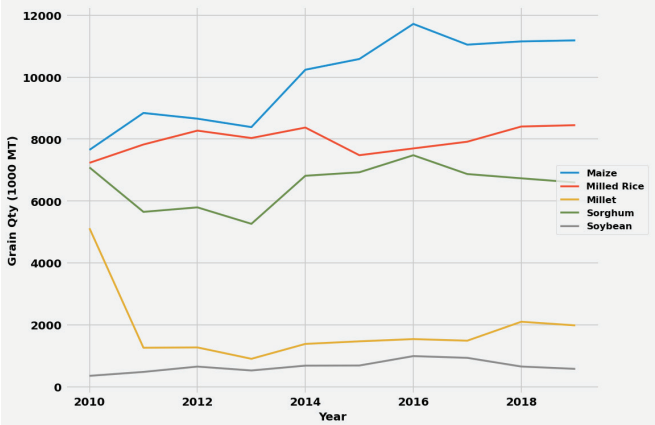

Figure 15: 99% Target Consumptions - estimated using equation 1 in section 3.4.

Source: Author, 2022

In Figure 16, the interest is in the region of the plots below the zero line. Maize had a shortfall of 187 (1000MT) in 2016. Rice had shortfalls of 66 (1000MT), 245 (1000MT) and 669 (1000MT) in 2016, 2017 and 2018 respectively. The supply of rice improved in 2019. Millet had shortfalls of 121 (1000MT), 12 (1000MT), 18 (1000MT) and 426 (1000MT) in 2010, 2017, 2018 and 2019 respectively. Sorghum had no shortfall from 2010 to 2019, meaning the country was self-sufficient in sorghum supply within this period. Soybean

had shortfalls of 37 (1000MT), 47 (1000MT) and 12 (1000MT) in 2011, 2012 and 2016 respectively.

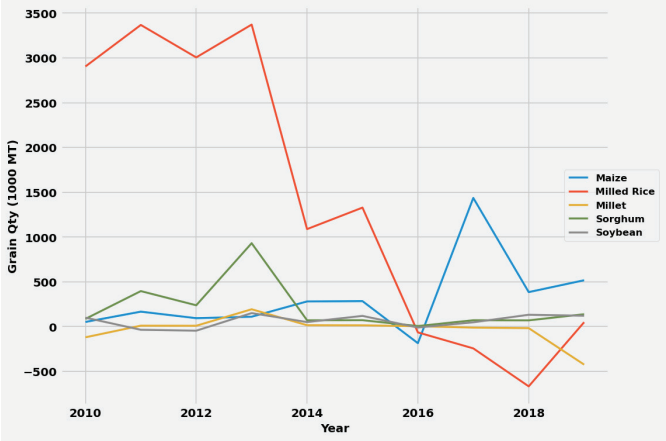

Figure 16: Shortfalls for 99% Target Consumptions - estimated using equation 1 in section 3.4.

Source: Author, 2022

Table 6 shows that at 99% target level of consumption, the total optimal stock is 1,299,720 MT. From the 97% target level of consumption, it is no longer required to stock maize; that is, the country's actual supply can meet up to 97% level of consumption in maize. According to the data used for this analysis, even at the 99% target level of consumption, there is no shortfall in sorghum supply; that is, as of the year 2019, the country is self-sufficient in sorghum production. The desired minimum level (target consumption) suggested as the ideal is 95%, but percentages higher or lower can be chosen by any country. Furthermore, at any given year, only one target level can be applied to any food grain. In the case of millet, milled rice and soybeans, even at 93% target consumption, the country still has shortfalls in the three grains and therefore needs optimal stocks in them.

4.6.2 Results Computed Using Consumption Figures - Different Per Capita Consumptions Reported for the Grains (equation 2 in Section 3.4)

The use of per capita consumption usually results in high and sometimes unrealistic consumption figures. Estimated consumption figures through per capita consumption are always increasing with the years because they are based on population, thereby hiding the effects of things like inflation and import policy. Furthermore, there is so much generalization for the following reasons among others: 1) The grains of interest are not consumed to the same degree in all parts of the country, and 2) the different parts of the country have different favourite staple foods. For instance, most people in the Southern part of the country hardly eat millet-based foods. Likewise, in some parts of the North, cocoyam and cassava-based foods are rarely consumed.

Figure 17 shows consumptions computed using different per capita consumptions for the grains. For all the grains, consumption linearly increased from 2010 to 2021 because the population figure, which keeps increasing by the year, was multiplied by a set of constant values over the period under consideration. No deductions can be made because the effects of reality on consumption are hidden in the chart.

In Figure 18, maize had shortfalls of 1,715 (1000MT), 664 (1000MT), 1,183 (1000MT), 1,709 (1000MT), 98 (1000MT), 234 (1000MT) in for 2010, 2011, 2012, 2013, 2018 and 2019 respectfully. Rice had shortfalls of 1,078 (1000MT), 1,270 (1000MT), 1,437 (1000MT) and 915 (1000MT) in 2016, 2017, 2018 and 2019 respectively. Millet had shortfalls from 2010 to 2019 with the highest of

Table 6: Optimal Stocks for Various Target Levels of Consumption – 2019

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Sum Total (1000MT)
99%	186.63	669.11	426.00	0	17.98	**1,299.72**
98%	68.26	584.22	406.00	0	16.96	**1,075.44**
97%	0	499.33	386.00	0	15.94	**901.27**
96%	0	414.44	366.00	0	14.92	**795.36**
95%	0	329.55	346.00	0	13.90	**689.45**
94%	0	244.66	326.00	0	12.88	**583.54**
93%	0	159.77	306.00	0	11.86	**477.63**

Source: Author, 2022

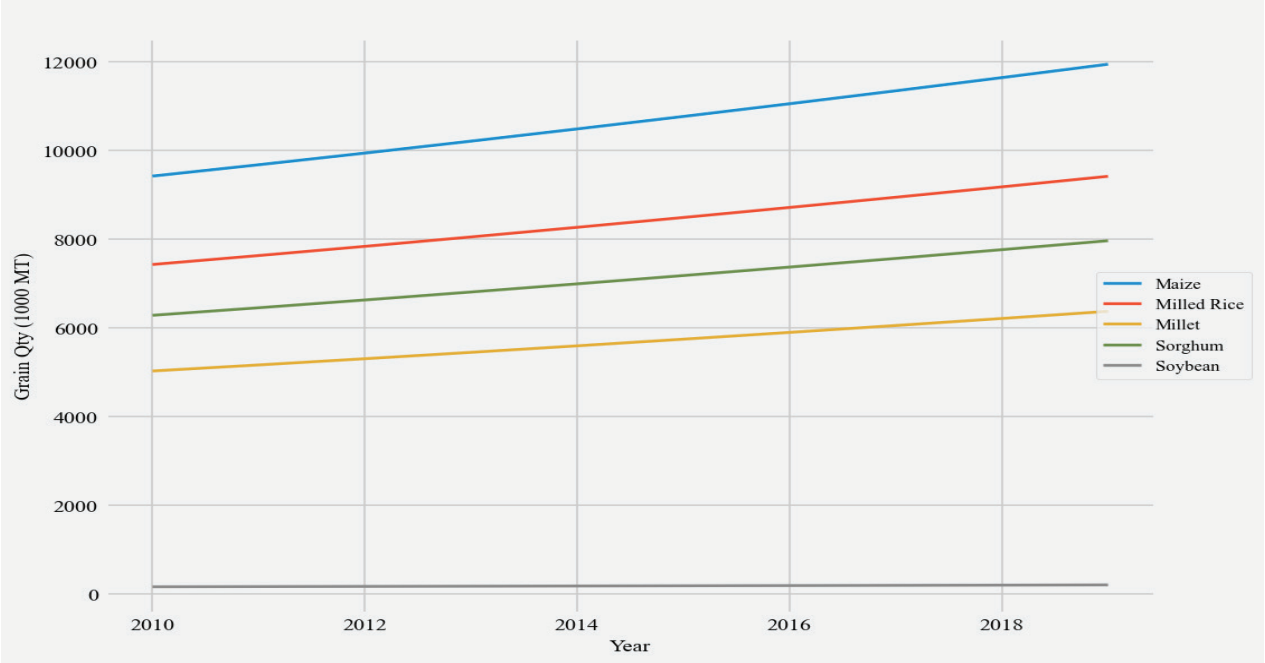

Figure 17: 99% Target Consumptions
Notes: Consumptions are estimated using equation 2 in section 3.4.

4,812 (1000MT) in 2019. Apart from 2010 and 2016, sorghum had shortfalls in other years with the highest of 1,224 (1000MT) in 2019. From 2010 to 2019, soybean had shortfalls and the highest of 115 (1000MT) was in 2019. All the high figures of shortfall recorded, in some cases, show that the use of per capita consumption can generate abnormal results.

Here, consumption figures are computed using different per capita consumptions for the grains, but all other procedures in Annex XI apply. Values of per capita consumption used are 60.0, 47.3, 32.0, 40.0 and 1.0 (kg/person/year) for maize, rice, millet, sorghum and soybean respectively.

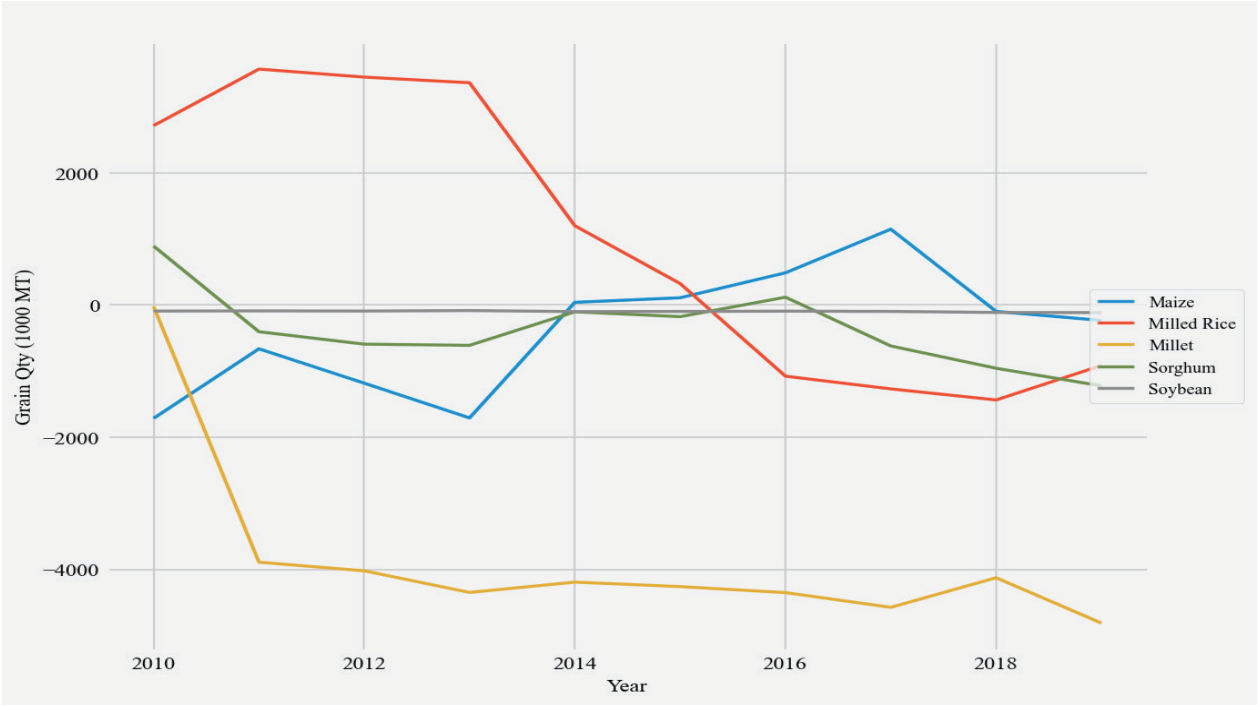

Figure 18: Shortfalls for 99% Target Consumptions - estimated using equation 2 in section 3.4.
Source: Author, 2022

Table 7 shows that at 99% target level of consumption, the total optimal stock is 9,304,990 MT. At a 93% target level of consumption, the country still requires optimal stocks to take care of shortfalls in the supply of all five food grains..

4.6.3 Estimation of Optimal Capacity

The capacity of a country's emergency reserve is not measured by the available storage space but by the magnitude of the content of the storage space. The principle behind this model is that variations in the consumption long-term trend of previous years should provide constraints rather than the available resources in a country.

Consumption figures used to estimate the values in Table 8 are estimated using production, import and export according to (1) in Annex 22. At 99% target consumption, the optimal capacity is 32,862,060 MT. As mentioned earlier, only one target level of consumption can be applied to any food grain in a year; and the higher the target level, the higher the degree of meeting the consumption needs of the country

Consumption figures used to estimate the values in Table 9 are estimated using 60, 47.3, 32.0, 40.0 and 1.0 kg/person/year for maize, rice, millet, sorghum and soybean respectively. At 99% target consumption, the optimal capacity is 35,871,470 MT.

Table 7: Optimal Stocks for Various Target Levels of Consumption – 2019 (consumptions estimated using equation 2 in section 3.4)

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Total (1000MT)
99%	1,715.08	1,437.24	4,812.54	1,224.17	115.95	**9,304.99**
98%	1,619.98	1,344.59	4,748.23	1,143.79	113.94	**8,970.53**
97%	1,524.87	1,251.94	4,683.92	1,063.40	111.94	**8,636.08**
96%	1,429.77	1,159.29	4,619.61	983.02	109.93	**8,301.62**
95%	1,334.67	1,066.64	4,555.31	902.63	107.92	**7,967.17**
94%	1,239.57	973.99	4,491.00	822.25	105.91	**7,632.71**
93%	1,144.47	881.35	4,426.69	741.86	103.90	**7,298.26**

Notes: Consumption estimated using equation 2 in section 3.4

Source: Author, 2022

Table 8: Optimal Capacities at different target levels of consumption - 2019

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Sum Total (1000MT)
99%	11,718.63	8,447.67	5,118.30	7,476.48	100.98	**32,862.06**
98%	11,600.26	8,362.34	5,066.60	7,400.96	99.96	**32,530.12**
97%	11,481.89	8,277.01	5,014.90	7,325.44	98.94	**32,198.18**
96%	11,363.52	8,191.68	4,963.20	7,249.92	97.92	**31,866.24**
95%	11,245.15	8,106.35	4,911.50	7,174.40	96.9	**31,534.30**
94%	11,126.78	8,021.02	4,859.80	7,098.88	95.88	**31,202.36**
93%	11,008.41	7,935.69	4,808.10	7,023.36	94.86	**30,870.42**

Notes: Consumptions were estimated using equation 1 and optimal capacity was estimated using equation 6 in section 3.4

Source: Author, 2022

Table 9: Optimal Capacities at different target levels of consumption – 2019 (consumptions estimated using equation 2 and optimal capacity estimated using equation 6 in section 3.4)

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Total (1000MT)
99%	11,937.26	9,410.54	6,366.54	7,958.17	198.95	**35,871.47**
98%	11,816.68	9,315.49	6,302.23	7,877.79	196.94	**35,509.13**
97%	11,696.10	9,220.43	6,237.92	7,797.40	194.94	**35,146.79**
96%	11,575.53	9,125.37	6,173.61	7,717.02	192.93	**34,784.46**
95%	11,454.95	9,030.32	6,109.31	7,636.63	190.92	**34,422.12**
94%	11,334.37	8,935.26	6,045.00	7,556.25	188.91	**34,059.78**
93%	11,213.79	8,840.21	5,980.69	7,475.86	186.9	**33,697.44**

Notes: Consumptions were estimated using equation 2 and optimal capacity was estimated using equation 6 in section 3.4

Source: Author, 2022

4.6.4 Optimal Stocks of Stabilization Reserve

The optimal level of stock in this context is the level of stock that ensures there is a sufficient supply of food grains in the distribution system in such a way as to have food grain prices stabilized.

USDA stock data for Nigeria are used for computations in this section. Relevant parameters contained in the data include production, beginning stocks, ending stocks, and imports and exports figures.

Trend lines generated from the regression are equations (15), (16), (17), (18) and (19) for maize, milled rice, millet, sorghum and soybeans respectively, where S_t are beginning stocks available for consumption in year t, S_t are the carryover stocks from the previous year t-1, PD_t are productions in year t, IM_t are imports in year t and EX_t are exports in year . The expression, $S_{t-1} + PD_t - EX_t$, is the total available supply in year t, out of which the ending stocks (S_t)that are going to be the opening stocks for year t+1, will be taken.

$S_t = 0.0519*(S_{t-1} + PDt + IM_t - EX_t) - 131.4828$ ..... (15)
$S_t = 0.0752*(S_{t-1} + PD + IM_t - EX_t) - 132.0123$ ..... (16)
$S_t = 0.1049*(S_{t-1} + PD_t + IM_t - EX_t) - 202.7502$ ..... (17)
$S_t = 0.1082*(S_{t-1} + PD_t + IM_t - EXt) - 204.1608$ ..... (18)
$S_t = 0.1142*(S_{t-1} + PD_t + IM_t - EXt) - 217.4418$ ..... (19)

The values of 0.0519, 0.0752, 0.1049, 0.1082 and 0.1142 for maize, milled rice, millet, sorghum and soybeans respectively in (15) to (19) are of interest; they are called stocking parameters. These values are used in the (13), $S_t^* = \frac{Y(X^*)}{(1-Y)}$, to calculate optimal stock levels for the grains. X^* is the target minimum consumption (95%) of any grain in year t.

Stocking parameters show the fractions of the total available supply that were always carried over to the next year from 2010 to 2021. The value for soybean is the highest (Table 10) showing that the level of soybean utilization in the country is low.

The stocks-to-use ratio is the ratio of market-year ending stock over total demand usage. From Table 10, stocks-to-use ratio values show that maize and milled rice were consumed more than other grains from 2010 to 2021, while soybean is the least consumed.

It can be seen from Figure 19 that the optimal stock level of rice has been the highest since 2017; there was a significant drop in 2018, then from 2019 it has been rising very significantly, hitting 962,350 MT in 2021. The market prices of rice have been so high in the past few years with the resultant reduction in its consumption. Therefore, a large quantity of rice would likely be required to stabilize prices in the markets.

Table 10: Stocking parameters and Stock-use-ratios

Grain	Stocking parameter	Stock-use-ratio
Maize	0.0519	0.0547
Milled Rice	0.0752	0.0813
Millet	0.1049	0.1172
Soybean	0.1142	0.1289
Sorghum	0.1082	0.1213

Source: Author, 2022

Sorghum usage as a raw material for larger beer and non-alcoholic malt beverage sectors can explain its high optimal stock levels. Between 2010 and 2012, some events would have led to a drastic drop in the optimal stock level of millet. In 2021, the total optimal stock is 2,691,470 MT consisting of 533,040 MT (maize), 962,350 MT (rice), 222,630 MT (millet), 751,630 MT (sorghum) and 221,820 MT (soybean). Annex X gives more details.

Overall, as shown in Figure 20, since 2010 the country's total supply has not been able to meet up with the total estimated consumption. The country was more food secure between 2013 and 2014. The supply deficit started and kept growing wider since 2017.

In the two-objective technique and in respect of the first objective, the value of B (0.75) in Table 11 corresponds to the year 2014. The year 2014 falls into the period between 2010 and 2021 when the country was relatively food secure compared to later years (2015 – 2021). The end-year stock of 2,646,000 MT in 2014 (blue row) is the minimum

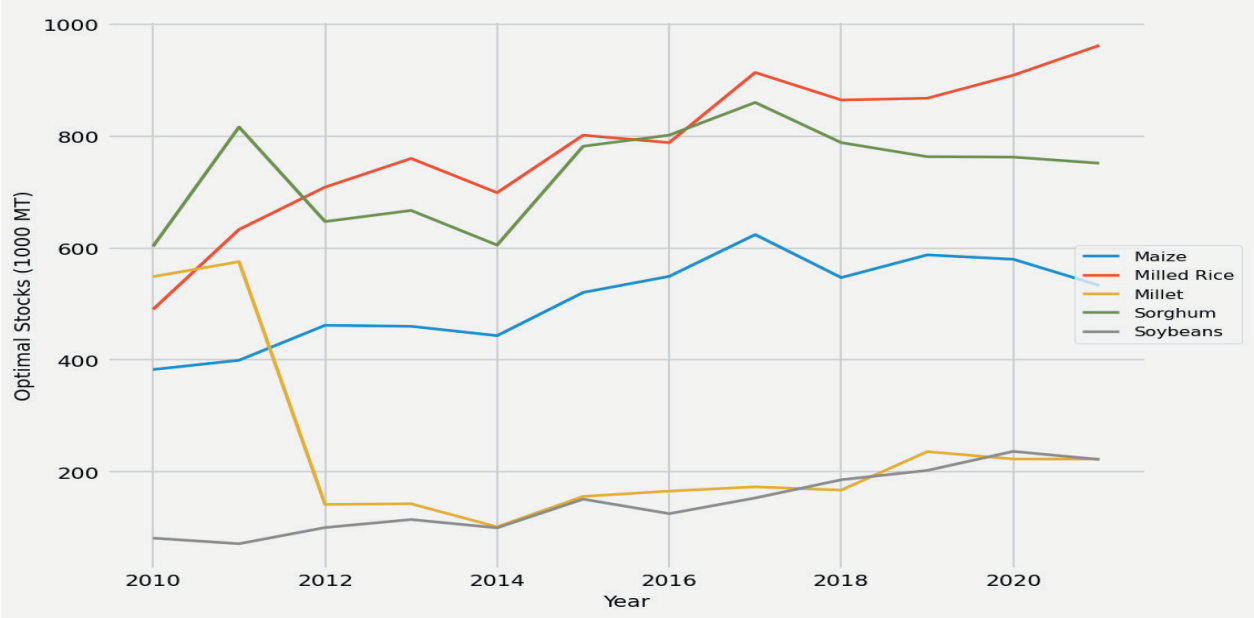

Figure 19: Optimal Stock Levels of maize, rice, millet, sorghum and soybean.

Source: Author, 2022

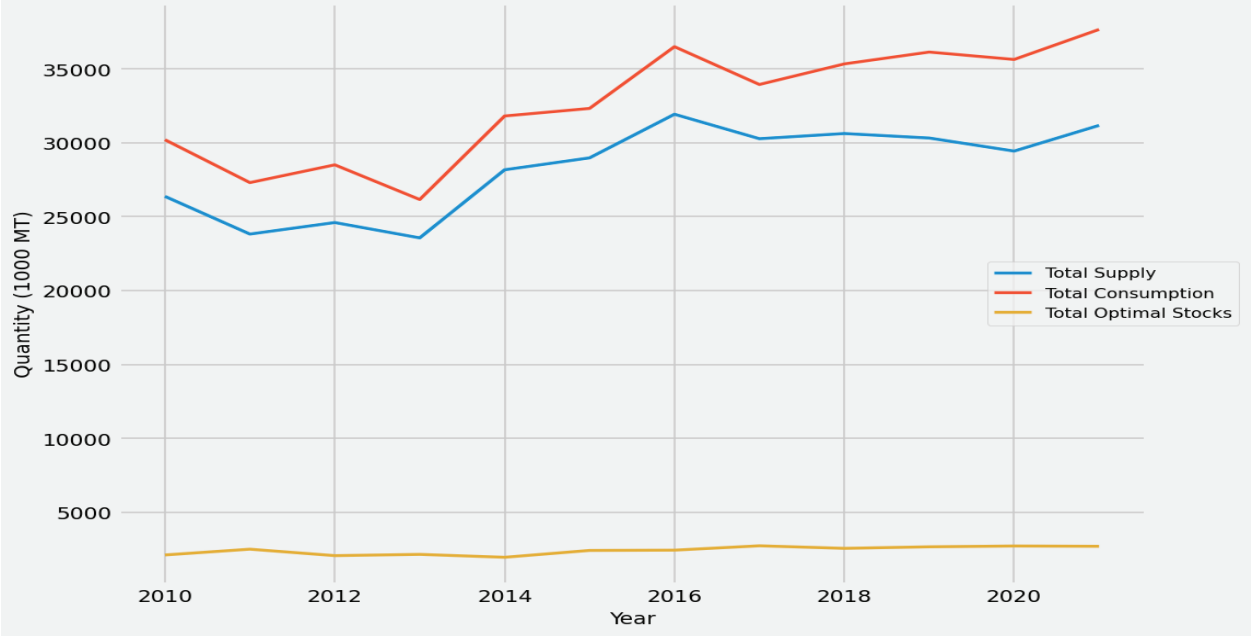

Figure 20: Total Supply, Total Consumption and Total Optimal Stock Levels.

Source: Author, 2022

Table 11: Buffer Stock Capacity Estimation 2010 – 2021

Year	End-Year Stock (1000MT)	Expected Demand (1000MT)	Utilization (1000MT)	Fraction of Expected Demand Utilized (1000MT)
2010	**956.00**	29350.00	24203.00	0.82
2011	**1428.00**	26893.33	28397.00	1.06
2012	**2076.00**	28220.00	25289.33	0.90
2013	**2063.00**	26774.67	26805.00	1.00
2014	**2646.00**	**32170.00**	**24115.67**	**0.75**
2015	**2140.00**	33144.67	30613.00	0.92
2016	**3150.00**	36726.00	29488.67	0.80
2017	**2280.00**	35001.00	35456.00	1.01
2018	**1926.00**	35423.00	32205.00	0.91
2019	**1405.00**	35650.33	33664.00	0.94
2020	**1288.00**	34607.67	33841.33	0.98
2021	**1595.00**	36463.33	32895.67	0.90

Source: Author, 2022

that is required to provide food security for the country in view of the first objective. The other end-year stock (green) that can be considered between 2010 and 2021, in view of the constraint for maximizing food security, (Equation 17), is 3,150,000 MT in 2016.

The second objective is to minimize storage space in line with constraints, (Equation 16). The space capacity of 225,000 MT held by the FGN after concession cannot be considered as the available grain storage space in the country. An alternative arrangement, by way of PPP and contributions from the State Government, should be considered so that at least the minimum of 2,646 (1000MT) can be stocked. If there is room for the country to maximize the food security constraint, the stock can be stepped up to 3,150 (1000MT) in green. The food security objective may not be further maximized to keep storage space as minimum as possible, but the minimum food security need of the country should not be compromised. The minimum stock of 2,646 (1000MT) required to give the country food security should not be further reduced. Any of the end-year stock values in red cannot be considered because they are less than the minimum food security stock. Only those end-year stocks that are higher than 2,646 (1000MT) and whose values are greater than B can be considered.

FSRD food transfers (section 1.2) revealed the highest single release of 40,000 MT to vulnerable groups in Table 1. However, the population of the affected persons could not be ascertained at the time of the compilation of this report. Section 3.2 showed that the projected population of the vulnerable groups by Cadre Harmonisé Result for Identification of Risk Areas and Vulnerable Populations in Twenty (20) Nigerian States and the Federal Capital Territory (FCT) of Nigeria is 19,453,305 (June to August 2022), which is about 9% of the total population of the country.

More importantly, the figure of 19,453,305 vulnerable people does not cover the entire country and cannot represent that of the entire vulnerable groups in Nigeria. The total population of vulnerable groups is vital to this study and extrapolation will certainly be required with the figure of 19,453,305 as a basis to make up for the remaining 16 states of the country.

The study is assuming that the spread of vulnerable populations in the remaining 16 states is the same as that of the 20 states where the survey was conducted. Although there is the possibility of over-estimation, it the safer to do so when making provisions for the vulnerable population. Therefore, by proportion, [(16/21) *19453305 = 14,821,566], the vulnerable population in the remaining 16 states is estimated at 14,821,566 bringing the total for the country to 34,274,871.

In addition to Cadre Harmonisé Report, the number of poor in the country is estimated to be 82,900,000 by the Nigeria Poverty Assessment

2022 (Figure 21). If it is accepted that a poor person is vulnerable, then the Nigeria Poverty Assessment 2022 is saying the vulnerable population in the country is 82,900,000.

Table 12 shows the suggested stock figures for the optimal stocks, buffer stocks and emergency reserves. Optimal stock, as it relates to the optimal reserve level, is meant to absorb historic production and supply shocks or shortfalls. Any year that a country becomes self-sufficient in some food grains production, optimal stocks are no longer required for the grains, since the

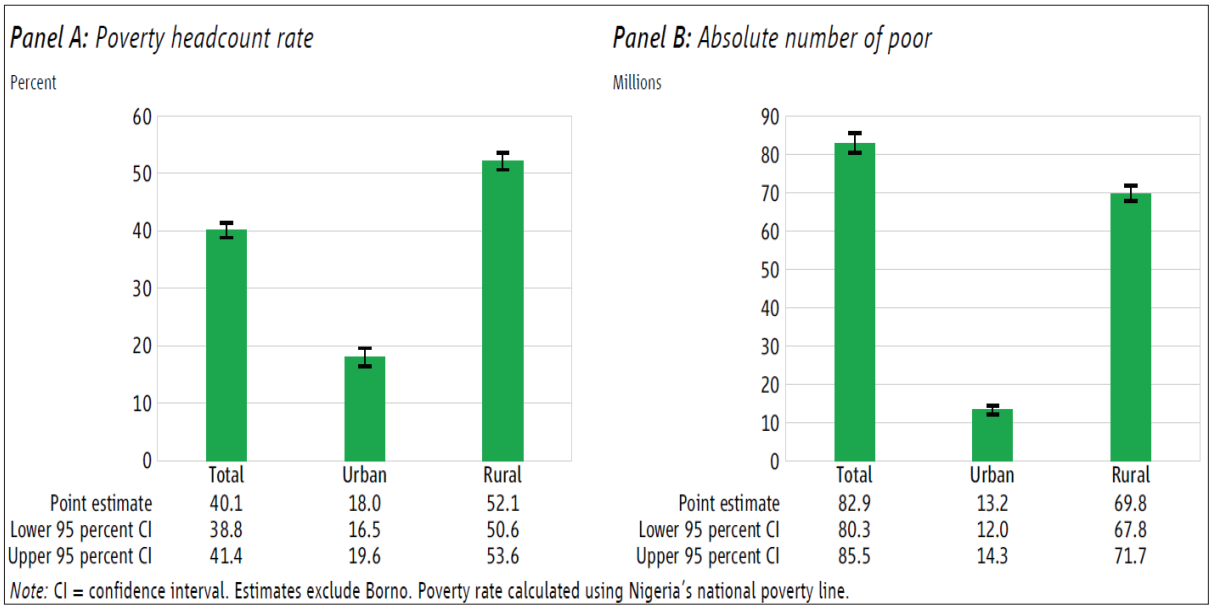

Figure 21: Poverty headcount rate and the number of poor people in Nigeria in 2018/19, by urban-rural.

Source: Nigeria Poverty Assessment 2022. A Better Future for All Nigerians. World Bank Groups

Table 12A: Estimates of the Sizes of Optimal Stocks and Emergency Reserve (2019) and Buffer Stocks (2021)

Item		Estimate for Nigeria's Population (200,964,000 in 2019)	Estimate for Cadre Harmonisé (Vulnerable Population 34,274,871)	Estimate for NIGERIA POVERTY ASSESSMENT 2022 (Poor Population 82,900,000)
Optimal Stocks (MT) – using consumption figures estimated from production, import and export data		**689,450**	**-**	**-**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	689,450/2 = **344,725**	-	-
Optimal Capacity of Emergency Reserve (MT) – using consumption figures estimated from production, import and export data		**31,534,300**	**5,378,247**	**13,008,268**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	31,534,300/2 = **15,767,150**	5,378,247/2 = **2,689,123**	13,008,268/2 = **6,504,134**
Buffer Stocks Capacity (MT)		**2,646,000**	**-**	**-**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	2,646,000/2 = **1,323,000**	-	-

Source: Author, 2022

Table 12B: Estimates of the Sizes of Optimal Stocks and Emergency Reserve (2021) and Buffer Stocks (2021)

Item		Estimate for Nigeria's Population (211,410,606 in 2021)	Estimate for Cadre Harmonisé (Vulnerable Population 34,274,871)	Estimate for NIGERIA POVERTY ASSESSMENT 2022 (Poor Population 82,900,000)
Optimal Stocks (MT) – using consumption figures estimated from production, import and export data		**828,850**	**-**	**-**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	828,850/2 = **414,425**	-	-
Optimal Capacity of Emergency Reserve (MT) – using consumption figures estimated from production, import and export data		**31,631,200**	**5,128,197**	**12,403,476**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	31,631,200/2 = **15,815,600**	5,128,197/2 = **2,564,098**	12,403,476/2 = **6,201,738**
Buffer Stocks Capacity (MT)		**2,646,000**	**-**	**-**
Suggested six months stock figures (MT)	3 months requirements plus another 3 months lead time to mobilize additional grain supplies	2,646,000/2 = **1,323,000**	-	-

Source: Author, 2022

country has no shortfalls in the supply of such grains. Therefore, optimal stocks in this sense can have high values during some periods and at other periods have low values. In this context, the optimal stock is relevant only in countries that are not self-sufficient in food grain production. In the context of buffer stocks, the optimal stock is about meeting the objectives stipulated in the definition stated earlier in section 3.1. A country that is self-sufficient in food grains production may still have buffer stocks for commercial purposes and for resolving food shortage issues during disasters or have an emergency reserve for disaster relief.

Analyses in sections 3.5.1 and 3.5.2 are of interest here. The results from section 3.5.1 are more realistic than that of section 3.5.2. Table 7 shows that using a 95% target consumption level, the total optimal stock is 7,967,170 MT (that is the country has to make provision for shortfalls in maize – 1,334,670 MT, rice – 1,066,640 MT, millet – 4,555,310 MT, sorghum – 902,630 MT and soybeans – 107,920 MT) as at 2019. This obviously is the consequence of possible generalization by using per capita consumption values and or inappropriate values of per capita consumption. Following from this, the results computed using consumption figures estimated from production, import and export figures (equation 1 in section 3.4) are considered for this final analysis. Using the Cadre Harmonisé-based vulnerable population of 34,274,871, the total optimal capacity computed using estimated consumption figures from equation (1) is 5,378,247 (34,274,871/200,964,000) x 31,534,300) MT.

The suggested figures for six months' provision for optimal stock are 344,725 MT. But looking at the suggested figures of six months provision for emergency reserve, 2,689,123 MT will be required for the vulnerable population of 34,274,871 (Cadre Harmonisé based estimation) while the poor population of 82,900,000 (Nigeria Poverty Assessment 2022 based), if they are qualified to be regarded as vulnerable, needs 6,504,134 MT. In view of the challenges that may arise in acquiring storage space for 6,504,134 MT of the grains, 2,689,123 MT is favoured for the emergency reserve over 6,504,134 MT, more so because the third model has shown earlier that 2,646,000 MT is the required stock for minimum food security for the country in a year.

As stated above, the third model showed that if the country can have a buffer stock capacity

of 2,646,000 MT, the minimum food security requirements would have been met. Therefore, the minimum stock level needed for the country's food security in the buffer stocks is 2,646,000 MT. This minimum stock level needed for the country's food security is well within the total figure of optimal stocks of the country's buffer stocks which is 2,691,470 MT (see Section 3.4 of the second model). The suggested figure for six months' provision for the buffer stock capacity is 1,323,000 MT.

The food balance of the country in FAOStat, which is the basis of analysis in sections 3.5.1 and 3.5.2, is from 2010 – 2019 at the time of this report. However, the results of the two sections (3.5.1 and 3.5.2) have been extended to cover 2020 to 2021 using Autoregressive Integrated Moving Average (ARIMA) for forecasting input data (production, supply, import, export and population). Details are presented in Table 12B and Annex 23 to Annex 26.

4.7 Conclusions and recommendations

The storage capacity of 225,000 MT held by the FGN is grossly inadequate. However, the maintenance cost of keeping a high proportion of the food grains in reserve will not only be too colossal but also unsustainable, given the present economic reality of the country as established in Result 1 (Economic Growth, Inflation, and Unemployment; Section 3.1, iii.).

The results showed that the recommended stocks are:

i. Optimal Stocks of **414,425** MT to offset historical shortfalls in supply.

ii. Optimal Capacity of emergency reserve of **2,564,098** MT for vulnerable groups; and

iii. Buffer Stocks Capacity of **1,323,000** MT for minimum food security requirements.

According to the definition of optimal stock (Goletti et al., 1991) in section 4.1., having an optimal stock in the buffer stock can help the country ensure a certain level of price stabilization and cater for vulnerable groups and other relief programs at minimum cost. In a year, the buffer stock capacity requirement is **2,646,000 MT** which, according to the third model is the minimum stock that will give the country food security. The foregoing shows that with a provision of **2,646,000 MT** in a year or a provision of **1,323,000 MT** twice a year in the buffer stock, the country can cope with its price stabilization, vulnerable groups and emergency reliefs. However, given the high cost of keeping a large physical stock, the Government should consider keeping both the physical and financial stocks to optimize the use of resources in stocking physical reserves.

5 Assessment of the Existing Storage Infrastructure Capacity

5.1 Background and process

To assess the existing storage infrastructure capacity, the study employed the following methods:

i). Review of the existing internal and external reports of the Food and Strategic Reserve Department (FSRD) to extract the status of each of the silos across the country and determine the capacity, the location, the state of performance of the infrastructure, provide cost estimates for those equipment requiring repairs, and those that will require an upgrade.

ii). Focus discussion with former and present relevant staff of FSRD of the Federal Ministry of Agriculture and Rural Development (FMARD).

iii). Physical and third-party inspection of government-owned silo complexes to determine status.

iv). The submission of a request to the Original Equipment Manufacturer (OEM) or their representatives to obtain the estimated cost for the repairs, upgrade, and rehabilitation.

v). Surveys on privately owned warehouses - FCT, Nasarawa, Kano, Oyo, Kwara, Ondo, Gombe and Enugu States.

vi). Survey data to establish the skill gaps and training needs of the staff at the FSRD Headquarters and at the silo complexes.

The Questionnaires were administered with the Open Data Kit (ODK) and analysed to determine the appropriate needs for staff and capacity development plan for more effective grain stock management for the country including especially analysis and detection of Aflatoxin.

5.2 The FSR Storage Capacity

The FGN has a total of thirty-three (33) Strategic Food Reserve Silos when fully completed, out of which seventeen (17) have been concessioned while sixteen (16) were retained by FGN for Strategic Food Reserve and Price-stabilization. A summary of the silos retained by the Federal Government and those which are still ongoing are presented in Table 13:

Table 13: Silo Complexes Under Government Control

S/N	Silo Location	Storage Capacity (MT)	Year of Completion	Ownership	Source of Stored Produce	Remark
1	Ilesha, Osun State	25,000	2015	Government retained	Contract with License Buying Agent's (LBA's) to supply	Operational
2	Minna, Niger State	25,000	1991	Government retained	Contract with LBA's to supply	Operational
3	Dutsin-Ma, Katsina State	25,000	2013	Government retained	Contract with LBA's to supply	Operational
4	Gusau, Zamfara State	100,000	2014	Government retained	Contract with LBA's to supply	Operational
5	Yola, Adamawa State	25,000	2016	Government retained	Contract with LBA's to supply	Operational
6	Lokoja, Kogi State	25,000	2019	Government retained	Contract with LBA's to supply	Completed but not operational
7	Lafia, Nasarawa State	25,000	2017	Government retained	Contract with LBA's to supply	Operational

S/N	Silo Location	Storage Capacity (MT)	Year of Completion	Ownership	Source of Stored Produce	Remark
8	Bauchi, Bauchi State	25,000	2019	Planned for Phase 2 Concession Programme	Not Applicable	Completed but suffered windstorm damage
9	Ilorin, Kwara State	25,000	2006	Planned for Phase 2 Concession Programme	Not Applicable	Under rehabilitation
10	Irrua, Edo State	25,000	1991	Planned for Phase 2 Concession Programme	Not Applicable	Operational, rehabilitated but not test-run
11	Maiduguri, Borno State	100,000	Ongoing		-	Over 90% completed. Work stalled due to insurgency
12	Uyo, Akwa Ibom State	25,000	Ongoing		-	Over 90% completed
13	Jalingo, Taraba State	25,000	Ongoing		-	Over 80% completed but suffered civil disturbance damage
14	Okigwe, Imo State	100,000	Ongoing		-	70% completed
15	Damaturu, Yobe State	25,000	Ongoing		-	Over 70% completed, work stalled due to activities of insurgence.
16	Yenagoa, Bayelsa State	100,000	Ongoing		-	Construction stalled due to topographical problems
	Total	**700,000**				

Source: Food and Strategic Reserve Department, 2022

5.3 Silo Complexes under PPP Arrangement

The Federal Government embarked on a concession programme with the technical support of the World Bank to bring the inherent private sector advantages into the running or management of the SGR silo complexes. Consequently, seventeen silo complexes are currently being managed by the private sector.

The private sector investors have taken over the complexes and have been undertaking repairs/ rehabilitation works for operations in accordance with their planned programme of works. The newly completed silo complexes have little, or no repair work except correction of installation defects, as in Igbariam (Anambra State) and Ikenne (Ogun State). Table 14 shows the status of the silos.

Table 14: Concessioned Silo Complexes

S/N	Silo Location	Capacity (Mt)	Year Completed	Concessionaire	Source of Stored Produce	Remarks
1.	Lafiagi, Kwara State	11,000	1984	Matrixville Limited	-	Not fully operational, equipment in good condition.
2.	Kwali, FCT	100,000	2014	Matrixville Limited	-	Not fully operational, equipment in good condition, weigh bridge and perimeter lightening repaired
3.	Balasa, Kebbi State	100,000	2014	Matrixville Limited	Combination of backward integration and agents	Operational equipment in good condition
4.	Jahun,Jigawa State	25,000	1991	Matrixville Limited	Use purchasing agents who buy from farmers and local markets	Operational- equipment in good condition
5.	Kaduna, Kaduna State	25,000	2006	Matrixville Limited	No stored produce	Not operational equipment is bad, repair work ongoing
6.	Makurdi, Benue State	25,000	1991	Upland Grains Production Company Limited	Backwards integration, farmers groups and agents	Operational-capacity utilization is 70.48%
7.	Gombe, Gombe State	25,000	1991	Independent Grain Handling and Storage Ltd	Backwards integration, farmers' groups and agents	Fully operational- capacity utilization is 100%
8.	Ibadan, Oyo State	25,000	2006	Serve well Agriculture Service Limited	Backwards integration, farmers' groups and agents	Fully operational-capacity utilization is 100%. Concessionaire built an additional weighbridge
9.	Ezillo, Ebonyi State	25,000	2006	Ebony Agro	-	Not operational equipment needs over-hauling
10.	Igbariam, Anambra State	25,000	2019	Coscharis Farms Limited	-	Not operational-water seepage in the intake pit & central elevator pit.
11.	Jos, Plateau State	25,000	2006	Agro-Universal Consortium	-	Operational, but the equipment is in bad condition
12.	Ogoja, Cross River State	25,000	1991	Agro-Universal Consortium	-	Not fully operational equipment is in good condition, renovation & repairs are ongoing.
13.	Akure, Ondo State	25,000	1991	Agro-Universal Consortium	-	Not operational, renovation on-going
14.	Sokoto, Sokoto State	25,000	2012	Agro-Universal Consortium	Rice Farmers Association of Nigeria (RIFAN)	Operational- equipment is in good condition.
15.	Gaya, Kano State	25,000	2018	Agro-Universal Consortium	-	Not fully operational-equipment is in good condition, renovation of civil structure ongoing.
16.	Ikenne, Ogun State	25,000	2017	Agro-Universal Consortium	-	100% capacity utilization. It is operational -Facilities in good working condition, being worked on for higher efficiency
17.	Ado Ekiti, Ekiti State	100,000	2019	Agro-Universal Consortium	-	Not operational,
	Total	636,000				

Source: Food and Strategic Reserve Department, 2022

Also, Figure 22 summarizes the distribution of silo complexes and their capacity as well as their operational status i.e fully operational/functional, partially operational and not operational. More than half of the capacity was not operational (17 out of 33 silos not functioning)

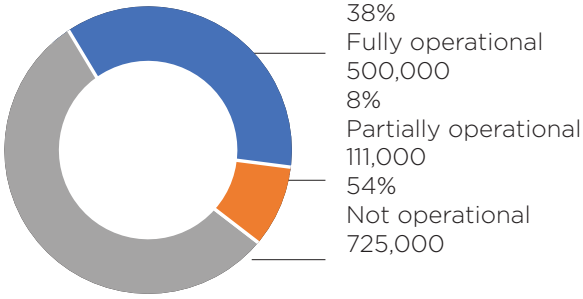

Figure 22: Distribution of Silo Complexes, their Capacities and by Different Types.

Source: Author

5.4 Private Owned Agricultural Warehouses

A survey was conducted to establish the distribution of private grain storage facilities (silos and warehouses) in Nigeria. Eight (8) States were randomly selected, namely FCT (54), Nasarawa (30), Kano (32), Kwara (50), Ondo (41), Gombe (31), Enugu (9), and Oyo (29) were surveyed. The survey revealed that the Maize Association of Nigeria (MAAN) has a total national storage capacity of 14,400 MT consisting of the following zonal storage capacities in warehouses: North-East Zonal Storage Capacity of 3,000 MT; North-Central 1,000 MT; North-West 10,000 MT; South-West 300 MT; South-East 50 MT; and South-South 50 MT. Some other major Agricultural warehouse operators with storage capacities ranging from 50,000-500,000MT included: AFEX, Dangote farms, Olams Nigeria, Stallion Group Nigeria, Newpal Nig Ltd and African Produce Technologies.

Table 15: Information on Sampled Private Storage Warehouses

S/Nos.	Description of Subject	Nos. of Respondents	Percentage of Total Respondents (%)
1	Storage capacity of < 10 Mt	32	12
	Storage capacity 10 < 20 Mt	55	20
	Storage capacity 20 < 50 Mt	41	15
	Storage capacity 50 < 100 Mt	43	16
	Storage capacity 100 < 200 Mt	35	13
2	Storage warehouses mainly for trading	167	61
3	Supplies obtained from the market	168	61
	Supplies obtained from owned farm	44	16
	Supplies obtained from owned farm/market	15	5
4	Store maize, beans and sorghum	76	28
	Store maize only	68	25
5	Sell to the market	169	61
	Sell to processors	61	22
	Sell market/processors	21	8
6	Destocking period (July - September)	101	37
	Destocking period (April - June)	75	27
	Destocking period (January - March)	34	12
7	Store for a period of 4-6 months	61	22
	Store for a period of 7-9 months	59	21
	Store for a period of 1-3 months	55	19
	Store for a period of 10-12 months	23	8
8	Advocated that government should obtain supplies through contracts	50	26
	Advocated that government should procure through organized cooperative groups	48	18

Source: Author, 2022

The analysis revealed that almost 50% of sampled facilities have storage capacities of 50MT and fall into the group of small-scale warehouse operators, with a potential of upgrading to higher capacities if facilitated; 61% are involved in grain trading and obtain their supplies from markets and the same percentage also sell to the market. These have a great influence on price stabilization hence there is a need to register and monitor market performance; 25% store only maize, while 28% store maize, beans and sorghum; 41% store for less than 6 months while about 62% store for less than 9 months, confirming that most warehouse operators are merely grain traders and can be given better focus to enhance price stabilization and food security.

5.5 Condition of Infrastructure in the FGN Retained Silo Complexes

The report summarizes the infrastructural challenges in the FGN retained silo complexes. It was noted that most of the silos, especially those under government management face various infrastructural challenges due to age or lack of adequate maintenance due to limited funds. This necessitates the need to carry out comprehensive repair and rehabilitation. The details of the infrastructure gaps and estimated cost of repairs are presented in Table 16A.

Table 16A: Condition of Infrastructure in Grain Reserve Silo Complexes Retained by Government

Silo Components	Minna	Ilesa	Gusau	Yola	Dustinma	Irrua
Weigh Bridge	Digital (Good working condition)	Digital (Good)	Digital (Good)	Digital (good working condition)	Digital (Good working condition)	Digital (Good working condition)
Control Panel	Analogue (Good condition)	Digital (Good condition)	Digital (Automated)	Digital (Automated) Needs minor repairs.	Analogue (80% automated)	Analogue partially good, dead bulbs. Temperature indicator bad.
Dry intake pit/ conveyor	Good	Good	Good	Good	Conveyer, chain needs repairs	Good
Wet intake pit/conveyor	Never been used (Good condition)	Good	Good	Good	Good	Good
Cleaner	Condition fairly good (75% efficiency)	Good	Fairly good (70%-80% efficiency)	Good	Good (80% efficiency)	Good
Elevators	Averagely Good	Good	Generally good working conditions	6 cups missing (Elevator 2)	Good, belt cuts slightly frequently	Good
Conveyors	Good. 5No aeration fan needs repairs	Good	Good	Conveyors 1 and 2 needs repairs	Chains needs rehabilitation	Good
Silo Bins	Some with leaking roof wall corroded	Good	Good condition	Good	Good conditions	9 of the bins have roof leakages
Discharge	Good (Auger)	Good	Good Auger	Good	Auger Good	9No augers have faults
Bulk loading	Good	Good	No bulk loading bin	Good condition	Good working conditions	Good
Bagging Plant	Bad. Air hose leakages due to age. Faulty stitching machine. Needs recalibration	Faulty: Problems with stich gear electrical faults, rewiring, calibration	Good condition	Good condition	Faulty. Needs 2no industrial stitching machine	Good

Silo Components	Minna	Ilesa	Gusau	Yola	Dustinma	Irrua
Tempering Bin (TB) and Temperature Probes (TP)	No TB TP bad	Good/ functioning TP TB, condition is good	Good/ functioning TP TB, condition is good	Presently only 2 functioning temp probes TB, condition id good	TP Good TB, condition is good	Probe temperature bad TB, condition is good
Hospital Bin	None	Good	Good	2No	Good	2No
Dryer	Not in use	Never used	Never used	Never used	Never used	Never used use.
Chutes	No leakages	No leakages	No leakages	No leakages	8 leaking chutes	Just rehabilitated. Not test run
Capacity	25,000MT	25,000MT	100,000MT	25,000MT	25,000MT	25,000MT

Source: FSRD, 2022

5.6 Cost Estimates to Upgrade/ Rehabilitate the Storage Facilities

The Summary of the estimated cost of carrying out the necessary technical upgrade and rehabilitation of the Silo facilities located at Dustinma, Minna, Ilesha, Gusau, Yola and Irrua as obtained unofficially from the equipment manufacturers is presented in Table 16B and the details are presented in Annex 1 to Annex 8.

Table 16B: Summary of Cost Estimates for Repairs/Rehabilitation of Faulty Components of the Silo Complexes

S/No	New Technological Components	Amount (₦)	Amount USD $
1	Cost of Installing New Technological Components in all silos	129,000,000	307,508.94
2	Dutsinma Silo Complex	50,002,000	119,194.28
3	Minna Silo Complex	68,700,000	163,766.39
4	Ilesa Silo Complex	8,000,000	19,070.32
5	Gusau Silo Complex	14,700,000	30,274.14
6	Yola Silo Complex	58,530,000	72,777.12
7	Irrua Silo Complex	80,700,000.00	192,371.87
	Total	409,632,000.00	904,963.05

Source: Equipment manufacturer representative (Unofficial), 2022
Note: A sketch of the silo layout and pictures of some of the faulty components are contained in Annex 10 to Annex 13

5.7 Condition of the Grains Reserve Concessioned Silo Complexes

The status and condition of the concessioned silo complexes are presented in Table 17 below:

Table 17: Condition of Infrastructure in Concessioned Grains Reserve Infrastructure Silo Complexes

S/N	Silo	Capacity MT	Concessionaire	Equipment	Ancillary Building	Remarks
1	Ado-Ekiti Ekiti State	100,000	Agro-Universal consortium	Very Good	Excellent	Not operational.
2	Akure Ondo State	25,000	Agro-Universal consortium	Good	Good	Not operational. Renovation on-going
3	Ikenne Ogun State	25,000	Agro-Universal consortium	Very Good	Excellent	Facilities in good working conditions. Equipment being worked on for higher efficiency. Operational.
4	Gaya Kano State	25,000	Agro-Universal consortium	Good	Good	Renovation of civil structures on-going. Not operational rehabilitation of equipment on-going.
5	Jos Plateau State	25,000	Agro-Universal consortium	Bad. (Needed attention).	Good	Operational, but equipment in bad condition
6	Ogoja Cross River State	25,000	Agro-Universal consortium	Good	Good	Renovation and repair works on-going. Not operational.
7	Sokoto Sokoto State	25,000	Agro-Universal consortium	Good	Good	Repairs and renovation on-going.
8	Kaduna Kaduna State	25,000	Matriville consortium	Bad	Very Good	Operational repairs of facilities on-going.
9	Kebbi Kebbi State	25,000	Matriville consortium	Excellent	Excellent	Operational minor repairs on-going.
10	Jahun Jigawa State	25,000	Matriville consortium	Good	Good	Operational. Repairs on-going.
11	Kwali FCT	100,000	Matriville consortium	Good	Good	Operational. Repairs on weigh bridge done. Renovation of structures on-going.
12	Lafiagi, Kwara State	11,000	Matriville consortium	Good	Good	Not fully operational, equipment in good condition.
13	Ibadan Oyo State	25,000	Flour Mills Nig Plc	Good	Good	New weigh bridge installed. Other repair works on-going operational.
14	Makurdi Benue State	25,000	Flour Mills Nig Plc	Very Good	Good	Operational capacity utilization was given as 70.48%. Weigh bridge changed to digital.
15	Gombe Gombe State	25,000	Flour Mills Nig Plc	Good	Good	Operational. Necessary repairs, upgrade done. 100% capacity utilization guaranteed.
16	Igbarian Anambra State	25,000	Coscharis Farms Ltd	Good	Good	Stored products in warehouse.
17	Ezillo Eboniyi State	25,000	Eboniyi Agro-Industries Ltd	Bad	Good	Equipment needs overhauling. Some repairs done. Not operational.

Source: Survey Report, 2022

5.8 Conclusion and Recommendations

FGN has 33 silo complexes projected to have a total storage capacity of 1.336 million MT when fully completed, 17 of them with a total capacity of 636,000MT have been concessioned. Six silo complexes (225,000MT) are directly managed by FGN, while Four silo complexes having a total of 100,000MT are completed and ready for Phase II Concession. The other six with a capacity of 400,000MT which are uncompleted should be completed and also concessioned.

There are no comprehensive records of privately owned agricultural storage warehouses. Most of the existing warehouses are unregistered and unregulated. However, a sample survey conducted revealed that there are few major private operators having storage capacities ranging from 50,000 - 500,000MT. Although MAAN has a large and organized network of affiliated farmers, it currently has about 14,000 MT storage capacity. The survey further revealed that virtually all the private sector operators are mainly into grain trading and could have a huge influence on the market prices. The study also revealed that the sum of $904,963.05 is required to upgrade/rehabilitate the FGN-managed silos.

The following are recommended for implementation:

i). FGN should immediately commence the Phase II of the concession programme with the newly completed/rehabilitated silo complexes in Lokoja, Lafia, Ilorin and Irrua to optimize the usage of the available silo facilities and avoid deterioration of the equipment.

ii). FGN should endeavour to complete the six uncompleted silos for further concession.

iii). FGN should put in place immediate legislation on the Agricultural Warehouse Storage Receipt System to facilitate effective private sector participation in the strategic food reserve.

iv). An effective and innovative fund mobilization strategy in partnership with development partners for the rehabilitation of the storage facilities should be embarked upon.

v). The cost estimate for the technical upgrade and rehabilitation of the FGN retained silo complexes is $904,963.05 (July 2022)

6 Capacity Development Plan for Optimal Grain Stock Management for the FSRD

6.1 Background

The capacity development findings presented in this section are based on a survey that was administered to the staff and managers of the Department through the Open Data Kit (ODK). The **Capacity Development** discussions in this section are segmented into three (3) sub-sections as follows; **Organisational**; **System**; and **Individual levels** to give perspectives on the details of the capacity needs of the FSRD.

6.2 Capacity Development at the Organizational Level

This section focuses on overall performance and functioning capabilities, such as developing mandates, tools, guidelines, and management information systems to facilitate and catalyse organisational change.

Slightly over half (56%) of the respondents agreed that the quality and quantity of human capital is a constraint to the FSRD as an organization. This is evidenced by the non-regular training for staff and the bureaucratic nature of the FSRD.

The majority of the respondents believed that the FSRD had strong linkages with Ministries (62.5%), legislators (50%) and the Private Sector (62.5% respondents). These linkages are key to influencing government policy on food reserves. Slightly over half of respondents opined that the staff of FSRD played advisory roles in the food and agricultural sectors for the Nigerian government. Over 70 percent of respondents affirmed that the department regularly provided policy advice on food and strategic grain reserve-related issues in the country. It was obvious that in the last two years, the FSRD was involved in the development of food and strategic grain reserve-related policy/strategy documents. However, only 18 percent of the respondents indicated that the Department possessed a sufficient capacity for the development of policies.

Although the Department lacks a fully functional M&E System, the majority of the respondents affirmed that it periodically produces M&E reports for learning and redefining programmes. The majority of the respondents affirmed that FSRD possessed an adequate capacity for data processing and analysis (60%) but a lower capacity for reporting and sharing.

The assessment showed the staff of the FSRD had adequate space to work. And this was attributed to the fact that the workspace is spacious enough to accommodate all, increases staff productivity, and the limited number of staff based at the headquarters. However, in terms of the workstation and tools especially the internet facilities, half of the respondents said the speed of internet connectivity in the FSRD is moderate, while a quarter noted it was low.

6.3 Capacity Development at the System Level

System-level capacity deals with the 'enabling environment', the overall policy, economic, regulatory, and accountability frameworks within which organisations operate. The analysis showed that the majority of the respondents strongly agreed that FSRD has clear operational plans to carry out its mandate and objectives which all members/staff fully understand. Similarly, the majority of respondents strongly agreed that planned outputs are delivered and that there are mechanisms in place to verify that its services meet client, stakeholder, or beneficiary needs.

Assessing the FSRD's capability to coordinate and relate i.e., the level of engagement of FSRD in networks, alliances, and collaborative efforts. Less than half of the respondents agreed that FSRD maintains effective coordination of its partner organizations and stakeholder groups and that such relationships with existing networks/ alliances/partnerships are effective.

Regarding the FSRD's capability to achieve policy and strategy coherence - the existence of mechanisms for coherence in the food and

agricultural sector – half of the respondents agreed that FSRD's operational guidelines achieve policy and strategy coherence, and the organization effectively follows them by working with the members and stakeholders.

Only slightly more than a third of the stakeholders agreed that the department participated in the committees/task forces/councils as an agency that is very central and strategic to food grain reserves in the country, especially food security-related networks and associations. This was confirmed by the lack of direct evidence of any research and analytical products from the FSRD being used by the committees/task forces/councils.

Furthermore, in the assessment of the capacity development at the system level (facilities & equipment) of the FSRD, the needed enabling environment to perform optimally was lacking. This is also a pointer to the limiting capacity identified earlier in the section because appropriate modern office tools to operate with were also lacking. Details as shown in Table 18 below.

6.4 Capacity Needs Assessment for Laboratory Equipment

The laboratories at the Headquarters and the six silo complexes directly managed by the government are not equipped to carry out advanced analysis such as mycotoxins, chemical residue analysis etc which had necessitated the use of NIPRD Laboratory Abuja and the NAFDAC Zonal Laboratory, Kaduna. The Study identified some of the requirements for FSRD to make them function efficiently as detailed in Table 19.

Table 18: Facilities and Equipment

S/No.	Physical Infrastructure, Facilities & Equipment	Actual	Intended	Gap
1	Computers	8	20	12
2	Equipping the Rata Room with a central data server for networking and associated components. Board	0	1	1
3	Microsoft Office Suite 360 for 50 users	0	1	1
4	Analytical Software SPSS	0	1	1
5	Qualitative analysis software, NVivo or ATLAS Ti	0	1	1
6	Carbon Sensors for the six silo complexes managed by FGN	0	6	6
7	Silo Spreader for the six silo complexes managed by FGN	0	6	6
8	Digital multigrain analyser for HQ and six silo complexes managed by FGN	0	7	7
9	Set of microtoxin equipment for HQ and six silo complexes managed by FGN	0	7	7
10	Chemical Residue analyser for HQ and six silo complexes managed by FGN	0	7	7

Source: Author, 2022

Table 19: Laboratory Equipment Need

S/No	Lab Equip.	Total	Unit Cost ₦	Amount ₦
1	Aflatoxin analyzer (EABI model)	8	3,500,000	28,000,000
2	Reagents	7		0
3	Oven Laboratory (Dry 27L)	7	244,031	1,708,217
4	Litmus Test Kits set, 10 pieces per pack	7	700	4,900
5	Multigrain analyzer	9	550,000	4,950,000
6	Digital Moisture meter	3	140,000	420,000
7	Hectolitre test Kit	1	135,000	135,000
8	Fume chamber		450,000	0
9	PH meter	1	350000	350,000
10	Short sampling probe	1	60,000	60,000
11	Long metallic Probe	1	120,000	120,000
12	Trays stainless	8	18,000	144,000
13	Digital Mini weighing scale	2	45,000	90,000
14	Insect bottles	17	700	11,900
15	Petri dishes 90mm, glass	1		0
16	Thermometer	1	12,000	12,000
17	Relative humidy meter		80,000	0
18	Mini oven	1	350,000	350,000
19	Refrigerator	7	70,000	490,000
20	Magnifying glass	1	6,000	6,000
21	*Set of sieve	2	73,000	146,000
22	Crucible with lid	7	550	3,850
23	*Beakers 250ml	1	700	700
24	*Microscope Binocular	8	155,000	1,240,000
25	**Worktable 240mm x 1200mm x 750mm		382,000	0
26	Stool		9,500	0
27	Relative humidity device	1	75,000	75,000
28	Cyanide free test kit	7	145,000	1,015,000
29	Sampling tray (Medium)	2	25,000	50,000
30	Lab bench	7	48,000	336,000
31	Sampling buckets	1	4,000	4,000
32	Sampling sacks	1	350	350
33	Stools	3	19,000	57,000
34	Lab cabinet	1	76,000	76,000
35	Illuminator	1	75000	75,000
	Total		**N**	**39,930,917**
			USD $[5]	**95,187**

Source: Prices from Four Manufacturer's Representatives (Unofficial)

5 CBN exchange rate of N419.50 to USD 1.00 as at July 2022

6.5 Capacity development at the individual level

Capacity development at the individual level deals with the processes of changing attitudes and behaviours, most frequently through imparting knowledge and developing skills through training, learning by doing, participation, ownership, and processes associated with increasing performance through changes in management, motivation, morale, and improving accountability and responsibility.

Human capital is a challenge in the FSRD. Less than one-fifth of respondents affirmed that FSRD had sufficient capacity for research, strategic policy analysis and investment planning; programme management, M&E; knowledge management and information sharing; leadership and management; and governance, organization, and institutional development.

Regarding the level of effective leadership in the SGR development process- only a third of the respondents agreed that the leadership, especially political leadership of the food and agricultural sector, is highly responsive. Close to half (44%) of the respondents agreed that the leadership provides strategic direction to the members of the organization. Only a third of respondents said members/staff have the skills necessary to effectively use the available evidence and knowledge to engage in policy discussions and dialogues. Less than a quarter (22.22%) of the respondents opined that appropriate incentives are in place to sustain members'/staff motivation to contribute to common food and agricultural policy goals.

Regarding the capability to adapt, learn, and self-renew, more than one-third (37.5%) of the respondents agreed that activities, outputs, outcomes, and performance markers generated through the M&E process address the goals of the food and agricultural sector's programs and policies. Regarding the responsive feedback mechanism, the majority (62.5%) of the respondents believed that FSRD is open and responsive to its stakeholders, and the public and in touch with general trends and developments in the food and agricultural sector respectively.

In the assessment of the staffing of the FSRD, it was obvious that areas of speciality requirements for the special skill sets required to operate the FSRD optimally are a big gap. The number of the needed professionals that are on board is inadequate; hence it becomes expedient for the FSRD to optimally perform in its roles and responsibility and deliver the statutory mandates, that onboarding these professionals is urgently required. Details as presented in Table 20 below.

Table 20: Capacity Needs Assessment for Staff

S/No.	Staff	Actual	Intend-ed	Gap
1	Director	1	1	0
2	Agronomists	4	6	2
3	Agricultural Engineers	13	19	6
4	Marketing officers	0	2	2
5	Agricultural Economics	2	3	1
6	Quality Control Officers	3	8	5
7	Entomologists	0	8	8
8	Microbiologist,	2	8	6
9	Scientific Officers	2	4	2
10	Data Analyst	0	8	8
11	Produce Officers	0	8	8
12	Logistics Officers	0	8	8
13	Nutritionists	0	2	2
14	Procurement Officer,	3	5	2
15	Research Analyst (Policy, Market and Storage)	0	8	8
16	Laboratory Superinten-dent	4	8	4

Source: FSRD, 2022

Table 21 below shows recommended possible solutions for the various weaknesses inferred from the CNA Questionnaires i.e management and staff plan to address the identified capacity gaps among the FSRD..

Table 21: Management and Staff Training Plan

S/No	Type of Training and Attendees	Learning Objectives	Learning Methods/ Activities	No
1	General Induction. **Attendees**: All staff	-Acquaint staff members on the Mission and Vision Statements of FSR, Goals and Objectives, Policies, and Code of Ethics	Presentation of papers on the various aspects	2
2	Human Resource Management (HRM). **Attendee**: Senior Management and Intermediate	- The function of Human Resources - Personnel and Organizational Effectiveness - Strategic Human Resource Management - Human Resource Planning. - Job Analysis, Design and Evaluation - Grievance and Discipline	-Interactive Class -Syndicate groups to discuss topics in the contemporary world	2
3	Discipline in the Workplace: **Attendee**: Junior Staff in separate sessions.	- Concept and Meaning of Grievances - Diagnostic Approach to Discipline - Disciplinary Process - Understanding Grievances - Types and Causes of Grievances - Handling Grievances.	- Classroom format	2
4	Agricultural Commodity Exchange and Warehouse Receipt System. **Attendee**: Management and Intermediate Staff	- Function of Commodity Exchange - Exchange Organizational Structure - Component of Effective Commodity Market. - Derivatives: Forward, Futures, Options and Hedging. - Evaluation and Identification of Risk - Some Terminologies	Interactive mode and Syndicate groups	3
5	Monitoring and Evaluation (M &E). **Attendee:** Management and Intermediate Staff	- Fundamentals of M & E. - Importance of M & E - Benefits and Dangers of E-commerce - Data collection and Analysis. - Evaluation. - Report Writing.	Lectures and Group Discussions	3
6	Silo Operations and Maintenance. **Attendees**: Silo operator and technicians	- Impact the requisite skills required to operate the silo facilities more efficiently. - Trainees will acquire the skills on routine and preventive maintenance and avoidable unnecessary breakdowns and down time. - Strategies to keeping low the cost of maintenance.	Intensive In-plant training	3
7	Basic Integrated Pest Management. **Attendees**: Assistant Managers and laboratory technicians.	- Trainees will learn the management of grain stock using a combination of appropriate application of storage chemical and other pest management practices	-In plant	3
8	Grain Reception and Grain Stock Management. Attendees: Quality Control Officer, Laboratory officers Weigh Bridge Officers	Trainees: Grain Sampling Equipment and Tools - Grain Sampling Methods, Analysis and records. - Acquire skills on the day-day management of grain stock both bulk and bag storage - Taking appropriate actions based on weather conditions. - Agricultural Commodities Standards and Grades.	-In plant	4

S/No	Type of Training and Attendees	Learning Objectives	Learning Methods/ Activities	No
9	Health Safety and Environment. **Attendees**: All staff.	- Staff will be acquainted with Health Safety and Environment. - Scope of operations of sickbay - Labour laws	Separate Sessions will be held for the senior and junior staff.	2
10	Introduction to Internet and Intranet: **Attendees**: Group I: Senior Staff Group II: Junior Staff	- Introduction to Internet and Intranet - Web Browsers - Navigation - Uniform Resource Locator (URL). - Emails	- Hands-on	2 Day
11	Basic Statistical packages: **Attendees**: Staff new to computer appreciation.	Trainees will be acquainted with the use of integrated Microsoft office (word excel and powerpoint presentation).	- formal classroom arrangement	3
12	Introduction to Database Management **Attendees:** System Administrator Data Entry Clerks.	- Database Management System - Advantages - Content of Database - Relational Database - Structural Query Language	- Hands-on	3
13	Processing, Handling and Storage of Agricultural Produce. **Attendees:** Feed Mill Staff Silo Operators	- Agricultural Value Chain - Post-harvest Value Chain - Agricultural Handling and processing - Agricultural Storage	Classroom Mode	3

Source: Author, 2022

6.6 Conclusion and Recommendations

he FSRD has good linkages with relevant Ministries Departments and Agencies (MDAs), legislators and private economy agents which have significantly affected policies on food security. The department has a clear operational plan to achieve its objectives. It works through operational guidelines to achieve policy and operational strategy. However, there is no evidence of any research and analytical products, neither is the M&E System fully functional. Although human capital is a big challenge, there is a high potential for research, strategic policy analysis and investment planning.

The following interventions are recommended.

i). FSRD should put in place a Monitoring and Evaluation system with appropriate tools, and performance indicators to track the desired results of the reserve.

ii). The capacity of the staff should be enhanced through regular training and capacity development activities.

iii) Government should source and provide the requisite funds for staff and equipment development programmes.

7 Resource Mobilization Strategies and Reforms to Improve the Functionality and Efficiency of the FSR

7.1 Strategies To Mobilize Resources For the FSR.

The traditional financing methods for the Food and Strategic Reserve (FRS) include government budgetary provisions or subventions, international aid, and loans from Regional or multilateral organizations. However, these methods may not be dependable and sustainable.

Financing strategic grain reserves through the capital market is an innovative and promising channel that can complement budgetary provisions. The Capital Market is a system for raising capital through the issuance and trading of financial instruments, such as stocks, bonds, and derivatives, (Agema, 2023). The Capital Market offers several instruments for financing strategic grain reserves.

Capital Market has the advantages of the diversification of funding, eliminating uncertainty in funding from a limited source of funding and sustainability. It provides access to a large pool of capital, allowing entities to raise funds from a diverse range of investors. In addition, Capital Market financing is flexible. The type of instrument used to raise funds can be tailored to the specific needs of the entity. Bonds, equities, and derivatives all offer different advantages and can be used to meet different funding requirements. For example, bonds offer a fixed income to investors, making them ideal for entities seeking a stable source of funding. Equities provide investors with an ownership stake in the entity and offer the potential for capital appreciation and dividends. Derivatives can be used to hedge against price volatility, reducing the risk associated with maintaining strategic grain reserves, as well as requiring disclosure and transparency, which can improve accountability and governance.

The African Development Bank (AfDB) demonstrated that Capital Market can be a very good tool to fund the Strategic Grains Reserve when it issued a $500 million social bond in 2020 to finance the African Union's Strategic Grain Reserve. The bond received strong investor demand, demonstrating the potential for financing strategic grain reserves through the capital market.

The Capital Market, however, has some weaknesses which include:

- **Creditworthiness**: Entities seeking to raise funds through the capital market must have a strong credit rating to attract investors.
- **Market volatility**: The capital market is subject to market volatility, which can affect the cost of financing and the ability to raise funds.
- **Regulatory compliance**: Financing through the capital market requires compliance with regulatory requirements, which can be complex and time-consuming.

There is a need to put in place a sustainable funding arrangement. Consequently, the following potential funding mobilization strategies for financing the FSR are recommended:

i). A strong synergy between the public and the private sectors to produce an efficient and effective Food Reserve System in Nigeria must be put in place. Such working relationships include the deepening of the ongoing management of the Food and Strategic Reserve silo complexes through the concessioning of more completed silo complexes to generate financial inflow as part of fees from the concessioners.

ii). The need to embark on advocacy and consensus building among the political leaders such as the members of the Executives (Honourable Ministers), National Executive Council (Governors of the 36 States of the Federation including the Minister of the Federal Capital Territory) and members of the National Assembly (Senators and Members of the House of Representatives) for the more budgetary provision and adequate funding of the silo system in view of its importance in the food security system.

iii). The findings of this report and the funding requirement should be shared widely with Donor and Development Partners and active steps taken to solicit funding support for the SGR gaps identified in this report.

iv). The urgent need to conclude the ongoing legislative process for the Warehouse Receipt System (WRS) which will enable the farmers to use their produce to obtain a warehouse receipt that could be used as collateral by farmers to obtain loans from banks and engage in more production of food grains for FSR. This will, in turn, facilitate more stock and more revenue for the reserve system, through the sales of agricultural commodities nationally, internationally and the World Food Programme.

v). Re-introduction of the Bill for Commodity Exchanges where the Strategic Food Reserve Value Chain will be a beneficiary from the Capital Market for transparency and funding.

vi). The government is to explore mechanisms for encouraging Donors and Development Partners to include support and funding of the Strategic Food Reserve in their funding programmes and strategies.

vii). To strengthen resource mobilization, there must be a legal and institutional restructuring by changing the structure of the current Department to an autonomous institution or Class A Parastatal or Agency such as the proposed National Food Reserve Agency (NFRA). The new organization should be empowered to participate in the financial markets and raise funds from the Commercial /Development Banks or Development Partners for investment into the operation and management of the silos, to cover the cost of operation to ensure its sustainability and continued operation of the business. This would allow the Buffer Stock to operate on a self-sustaining commercial model, like the Price Stabilization Programme of Kenya, with the government supplementing where necessary through price support.

viii). The government should fast-track the conclusion of the ongoing legal backing for the National Agricultural Development Fund (NADF) and prioritize the Strategic Food Reserve as a priority area of funding the NADF.

7.2. Reforms to Improve the Functionality and Efficiency of the FSR

7.2.1. Background

Consequent to the findings of this report, as presented in Figure 23 shows that the current FSRD model of operations and management is not cost-effective as designed. It does not promote sustainability – given the high and unsustainable operating cost leading to a high deficit between the income generated from the distribution of the food grains and the amount spent to procure and maintain the grains, without corresponding reimbursement from the government to the Reserve to offset the deficit at the end of the exercise.

Between 2014 and 2021, there was a wide gap in the quantum of funds released to the FSRD for the operations of the reserve programme and the amount of internally generated revenue. The revenue is very small when compared with the amount expended on procurement, maintenance, and other costs. In other words, FSRD generates very little revenue leading to overdependence on

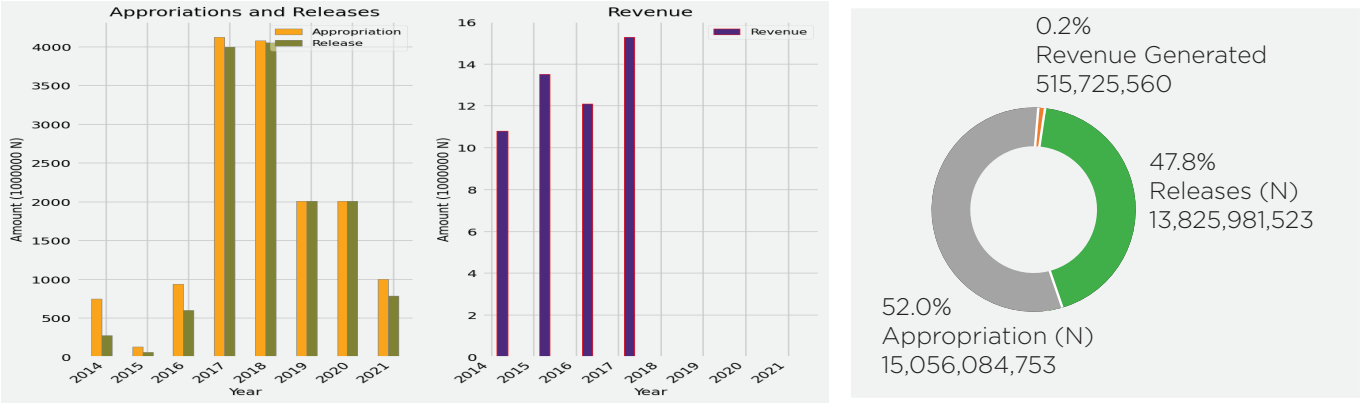

Figure 23:Total Figures of Appropriation, Release and Revenue (2014-2021).

Source: Budget Division of the FMARD, 2022

government appropriation and releases which has also been declining over the years due to several other competing needs for public funds. Given the foregoing, there is a necessity for a paradigm shift with the evolution of a management model that would make Food Reserve operations more efficient and sustainable.

This report has brought out the limitation of the current business model which necessitated the need to develop partnership models with the private sector in the stocking/release of food grains to/from the Regional/National FSR to enhance the attainment of the full objective of the Reserve.

7.2.2. Case studies of institutional structuring of SGRs

In Bangladesh, the Directorate General of Food is a Government Department in the Ministry of Food responsible for food management and policy. It is also responsible for the import of foods under Bangladesh government contracts. It is led by the Director General. The structure set-up was initially meant to build up a significant physical, publicly managed grain reserve. After its inception, the Food Department increased its public stock of wheat and rice to 2.2 million tonnes. However, the Directorate has evolved with time and experience and reduced the stocks held by two-thirds from the late 1990s. This reduction was made to reduce the excessive costs of storage that were being incurred. A physical reserve is thus not appropriate as a major food initiative, but only as a minor one to address the need for smooth emergency operations. **The Directorate is keeping a third of the stock and the rest is held virtually.** The weakness of this structure is that the Directorate is still embedded in the government thus it's not autonomous (market forces are not determining the grain prices but rather these are unanimously set by the government).

In India, the Food Corporation of India (FCI) is a statutory body created and run by the Government of India. FCI is led by Chairman and Managing Director who is a central government civil servant. The FCI is organised into five directorates: procurement, storage, transport, distribution, and marketing. Despite the FCI being embedded in Government, it is also notably autonomous, thus it can execute its duties without the interference of the Government. As a result, FCI has been very instrumental in stabilising food prices and fortifying food to make it available, safe, and nutritious to all sections of the population. The FCI has greatly improved the food security situation in India. The FCI structure has allowed virtual stocks to be held, the system implemented by FCI is highly technical and envisages an intelligence unit that provides scoured forecasted global grain prices and thereafter designs dynamic market prices for India. The organisation has a nation-wide network of godowns/warehouses that help in the efficient distribution of food grains. India was able to establish 2 million MT of food grain silo capacity across 36 different locations on a PPP basis. The PPP projects operate on a Design, Build, Finance, Own and Operate (DBFOO) basis (World Bank, 2014).

In Kenya, the National Cereals and Produce Board (NCPB) is a commercial State Corporation under the Ministry of Agriculture. It is mandated to provide logistics support services to the government on food security and carry out market intervention for grains and to trade commercially in maize, rice, wheat and in an array of pulses such as beans and green grams. NCPB offers Warehouse Receipt System (WRS) services and has leased out some of the warehouses to the private sector. NCPB has been restructured into two distinct divisions: The Strategic Food Reserve Board (SFRB) division and the NCPB Trading division. The SFR oversees food security and manages the National Food Reserve Fund. Kenya's National Cereal and Produce Board has decided to double the reserves it stores from 4 million to 8 million sacks of 90 kg. The total of 720,000 tonnes will be almost entirely domestically purchased maize. The NCPB has drastically reduced the amount it purchases on the market, leaving the private sector with enough quantities to buy and thrive. The Board has geographically restricted its purchasing activities to just one province (Rift Valley) which is a national breadbasket thereby allowing traders to play a role in other locations.

It is imperative to note that the SFR is not dominated by humanitarian stock but rather food security stocks. Despite doubling the stocks held by the SFR, two-thirds of the stocks are held virtually through a Fund. More than 95% of the stock purchased is maize, even though the SFRTF has six other commodities in its mandate; this puts pressure on maize and non-nutritious diets for emergency food.

7.2.3. Proposed NFRA Institutional Structure Model

The proposed models discussed below are adapted from best practices, with a bias toward India's model. The reformed Model for FSRD is expected to possess the following attributes: prompt response to food emergencies or vulnerability needs of the population; stocking and destocking of good quality food commodities in the right mix of marketing strategy, that stocking/destocking are transacted in the most competitive manner; managing the stock in a most effective and efficient manner; maintaining accurate stock and financial records; implementing a robust logistic network; innovatively provide a solution to evolving issues.

First, there is a need to build up a physical grain reserve through technical upgrading/rehabilitation of storage facilities (silos and warehouses) in the country and stocking. Physical reserves are however not appropriate as the only major country initiative, because of the high costs involved and logistical nightmares. Physical stocks should be used as a stop-gap measure to address the need for smooth emergency operations. One way to minimize storage costs could be an internationally coordinated arrangement for shared reserves through virtual reserves. In essence, a small, independent physical emergency reserve and a virtual reserve and intervention mechanism backed up by a financial Fund would avoid problems that have been faced by the current Nigeria institutional structure while ensuring that the country can respond to emergency needs for food and prevent extreme price spikes.

The Government should **consider keeping both the physical and financial stocks** in line with ECOWAS policy and optimize the use of resources in stocking physical reserve, as well as the management of the financial reserve which eliminates cash flow problems, and such funds are encouraged to be held in the foreign currency to protect it against devaluation. It also allows for flexibility of operations in times of emergency. To ensure that the funds allocated for financial stocks are not diverted, the same can be kept in an Escrow Account of the Central Bank of Nigeria (CBN). However, there must be political will and discipline to implement the Escrow Account arrangement.

The new institutional structure should have a research/intelligence unit that would forecast prices by combining an assessment of the fundamental component (supply and demand factors) with a medium-term to long-term financial model in which the spot price of the commodities at a certain time is decomposed into stochastic factors. The unit would design a widely defined price band based on the forecasting model. The model would trigger the alarm to the high-level technical commission that prices are significantly outside their estimated price band (that is, prices are approaching a spike) based on the dynamic price band system (IATP, 2012).

7.2.4. Partnerships with the Private sector

Public funding has proven inadequate for maintaining a robust and sufficient grain reserve. The government already owns silo and warehouse storage facilities, although in need of rehabilitation and modernization. Some government-constructed silo storage facilities have been underutilized or never used at all, resulting in opportunity cost losses to the government. Based on a longer-term plan to increase rice production in the country and the development of commodity exchanges, a partnership with the private sector is a viable option to improve the situation.

Greater private sector participation is essential to increased efficiency, capacity utilization, and reduced burden on public financing of food reserves. Similar models have been implemented in India, and Kenya, among other countries. India for example implemented an ambitious program to scale up long-term food storage PPPs with assured payments to the private operators for storage of guaranteed minimum quantities of food grains over defined periods.

In 2012, Nigeria's Federal Ministry of Agriculture and Rural Development (FMA&RD), which manages the 33 silo complexes built by the government signed a Memorandum of Cooperation with the Infrastructure Concession Regulatory Commission (ICRC) to concession out the silo complexes. To fully operationalize partnerships with the private sector, the FSRD should be restructured and legally mandated to implement a Public, Private Partnership (PPP) model. This will allow the re-structured FSRD to partner with private economic agents such as private warehouse receipt companies, companies involved in the storage of food grains, and grain aggregators, among others. This will enable the Department to focus on investing in public goods such as basic infrastructure (silos, warehouses, etc.) and

ensuring a supportive policy, and regulatory and business environment to reduce risk and transaction costs while partnering with the private sector on other services which they can provide more efficiently. Producers will be linked to the Food Reserve by traders who purchase grains and supply them to the FSR. Millers, processors and other actors will not only produce food grains and supply the excess to the reserve, but also invest in processing facilities, warehouses, and transportation, providing market intelligence, technology and specialized technical assistance. The following private-sector partnership mechanisms should be implemented.

7.2.5. Capacity Utilization - Concessioning and Leasing Model

The Government effort in the concession of the seventeen (17) unutilized silos capacity space of 636,000 MT should be seen as the right step in the right direction, for example, the Flour Mills of Nigeria (FMN) is currently operating the three (3) silos in Gombe, Makurdi and Ibadan efficiently. The programme is aimed at increasing the private sector participation in grain storage and complementing the food security efforts of the government. In addition, it will put to effective utilisation of the existing unused storage space and relieve the government of the unnecessary financial burden of maintaining empty silo complexes, and instead generate revenue from the concession agreement. Furthermore, the concessionaires are expected to incorporate backward integration in sourcing supplies. This strategy will not only boost production but also create employment and increase capacity utilization The government should draw from lessons in the past concession arrangement, to review the strategy and allow more private sector participation in the use of the facilities, thus deepening the policy of concessioning by embarking on the implementation of Phase 2 of the programme.

7.2.6. Engaging Small Agricultural Producers and traders

There were indications from some of those interviewed during this study that the impact of the activities of the FSRD is not fully felt by the small-scale agricultural producers due to its non-inclusiveness, which means all the actors along the value chain such as the farmers, processors, aggregators, marketers, among others, must be involved.

Smallholders (small-scale farmers) are very important for agriculture sector development in Nigeria. Over 80% of the farmers in Nigeria are classified as smallholders with land holdings of less than 5 hectares. They produce 99% of Nigeria's agricultural outputs, in spite of the very many challenges ranging from the lack and high cost of labour and agricultural inputs in rural areas; limited access to information, modern agricultural technology, and adequate financial services; a land tenure system that prevents the acquisition of new land; and inconsistent support from local government councils (Jamie Anderson et al., 2017). It is therefore necessary to implement mechanisms that create value for smallholders from FSRD activities. The proposed models are as follows:

a) **The Warehouse Receipt System Model.**

The Warehouse Receipt System is a veritable model that can be employed to link small agricultural producers to the FSRD/NFRA. The FSR can obtain its supplies through the WRS, thus increasing farmers' remuneration. However, the enabling law for the operation and implementation of the Warehouse Receipt System is not yet in place. At present, the operators of the WRS work closely with group farmers and commodity associations all over the country. When the WRS is fully developed, the average Nigerian farmer should be able to obtain the receipt and use it to secure credit facilities at any financial institution for subsequent production and its disposal to either aggregators, warehouse operators or NFRA/FSRD directly. There is therefore a felt need to facilitate and promote the development of the operation of the WRS in the country to bring it to the standard of the most developed markets around the world. Farmer groups should be able to aggregate their produce in aggregation centres and utilize the Warehouse Receipt System or directly supply to FSR.

b) **Value Chain Model.**

The potential of Small Agricultural Producers is better tapped if the individual producers come together under one organisation to take advantage of economies of scale. Under this arrangement, the farmers' groups and the aggregators can be facilitated with credit service through the relevant financial

institutions, to enable them to produce in anticipation of the approved Guaranteed Minimum Price (GMP) at the same time sell to the proposed Licensed Buying Agents (LBAs) at the GMP (cost recovery price). The Federal Government of Nigeria can support groups of farmers and aggregators to make use of the established grain aggregation and bulking centres to store, dry, clean, grade and bag produce to ensure their storability and acceptability to FSRD and the processors. The government can support the implementation of the GMP by purchasing at GMP through the National Food Reserve.

7.2.7. Coordinated Approach Model to address the plight of vulnerable groups, social safety nets and poverty by MDAs.

In addition to NFRA, NEMA and other agencies of the Federal Government of Nigeria handle the supply of food grains to address the plight of the vulnerable groups of society. To avoid duplication, NFRA must work closely with the National Emergency Management Agency (NEMA) which has the mandate for addressing disaster-related issues through the establishment of well-formulated policies and procedures for activities relating to disaster management in the state. This will improve the coordination of plans and programmes for efficient and effective responses

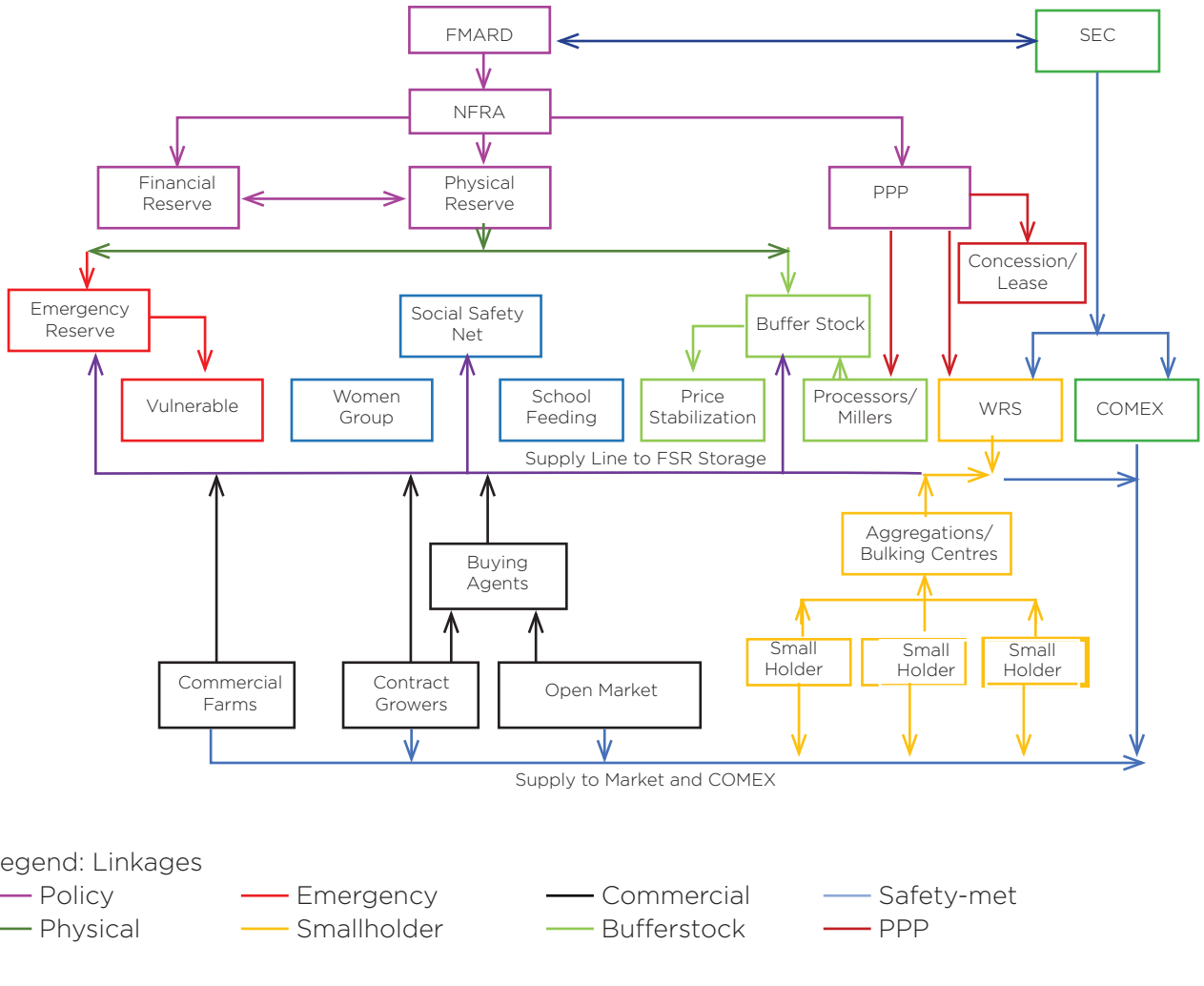

Figure 24: Integrated Value Chain Reserve Management Model.

Source: Author, 2022

to the disaster at all levels. NEMA should be able to submit its requirements for food grains at the beginning of every year to NFRA which will be able to stock and allocate food grains to NEMA at any point in time. Under this arrangement, NEMA should consult with NFRA before going to the market to procure food grains.

7.2.8. Agricultural Market Information System

According to the guidelines for the establishment of a Strategic Grain Reserve published by the Food and Agriculture Organization (FAO) of the United Nations, a reliable Agricultural Market Information System (AMIS) for monitoring the overall food situation in the country is an important tool. In line with the assessment of market developments, the government will be able to take necessary decisions on when to buy and stock, import or export, and the likely need for releases from the reserve during the marketing year to cope with envisaged food shortages. Important parameters for decision-making include prices, quantities, informal trade data, interregional trade and cross-border trade, wholesale trade, market prices, Cost, Insurance and Freight (CIF) and Free-on-Board (FOB). Other data that are important include crop production forecasts and early warning systems. Collection and analysis of reliable statistical data require quality and reliability of production forecasts and on the development of market information and early warning systems.

Market Information Systems can provide reliable information, and help the government avoid the high costs of coping with an unexpected food emergency. Market information is also very necessary for production and market forecasts with a direct bearing on the size of the strategic grain reserve needed to give the required degree of protection.

Current MIS and Data Status in FSRD

Presently, the arrangement in the department to collect, collate and analyse market data is weak. In the time past, FSRD did put in place an arrangement whereby Silo Managers were mobilized to collect market data on food commodities from various locations in the country. An application running on the FSRD server at the headquarters then was used to analyse the data and generate reports. The arrangement could not be sustained due to the limitation of funds and it had to stop.

Available market data have some shortcomings as a result of the types of formats with which they are reported (thus, some of them were contradictory). Some other available data are usually not up to date. Data on early warning factors like low rainfall, crop failures, pest infestation, trans-border markets, naira exchange rate, information parity index, volume and flow, which are vital, are not readily available.

Proposed MIS Strategies

The following are therefore suggested:

i). Development of a mobile platform to facilitate the collection of data from farmers, traders and other stakeholders and for the transmission of such data to the FSRD server where the data can be accessed for analysis and report generation. Collection of data with a mobile app will not only reduce secondary errors in the process of recapturing data from SMS and email, but it will also transfer the data straight into a server at the host agency in SQL or MySQL, where they can be accessed in real-time for analysis;

ii). For sustainability, a public-private partnership arrangement can guarantee the free dissemination of basic information supported by public resources, and sales of more elaborate or specific information (such as market analysis, quality specifications, etc). In addition, complementary income-generating services (brokerage, warehouse receipt system, storage, information package backing contracts between agribusinesses and farmers) could be provided.

8 General Conclusions and Recommendations

9.1 Conclusions

The study found that the FGN has 33 silo complexes projected to have a total storage capacity of 1.336 million MT when fully completed, 17 of them with a total capacity of 636,000MT have been concessioned. Six silo complexes (225,000MT capacity) are directly managed by FGN, while Four silo complexes having a total of 100,000MT are completed and ready for Phase II Concession and the other Six of 400,000MT which are uncompleted should be completed as soon as possible and also be concessioned.

The Study established that the Optimal Stock is 414,425 MT, and the optimal capacity of the Emergency Reserve of 2,564,098 MT which also serves the vulnerable groups. Also established is the stock level required to give the country minimum food security in the buffer stocks is 2,646,000 MT a year, which is 1,323,000 MT on the six-monthly provision.

The privately owned warehouse survey revealed that most of the existing warehouses have storage capacities ranging from 50,000 - 500,000 MT, they are unregistered and unregulated. It further revealed that the majority of operators of the warehouses are involved in trading, and obtained most of their supplies from the markets, which implies that they could inappropriately influence the market prices.

Three capacity development areas assessed showed that FSRD has good linkages with stakeholders on food security policies but lacks a fully functional M&E System. Furthermore, gaps were identified in Physical Infrastructures, Facilities and Equipment; Capacity needs for Staff; Laboratory Equipment. The study established that the estimated sum of $904,963.05 is required to upgrade/rehabilitate the FGN-managed silos and that the estimated sum of $95,187.00 is required for upgrading the laboratories.

The FSRD does not have a legal instrument backing it to operate as an autonomous government agency (that can respond promptly to management and operational issues) but as a department with limited authority within FMARD. The WRS also lacks the appropriate legal instrument to operate fully.

9.2 Recommendations

The government should implement the following to enhance the sustainability of the Food and Strategic Reserve.

i). Restructure FSRD through the requisite legal reforms to operate more flexibly, for example by upgrading the department into a Class "A" Parastatal as National Food Reserve Agency (NFRA) which can respond to issues very promptly with less bureaucracy

ii). Implementation of a Public Private Partnership (PPP) Model – the department should partner with private economic agents such as Private Warehouse Receipt Companies, Companies involved in the storage of food grains, and grains aggregators, among others, to improve efficiency and mobilize resources.

iii). The Government should make financial provisions to make up the recommended stocks as follows:

- a). Optimal Stocks of **414,425** MT to offset shortfalls in supply.
- b). Optimal Capacity of Emergency Reserve of **2,564,098** MT for vulnerable groups; and
- c) Buffer Stocks Capacity of **1,323,000** MT for minimum food security requirements.

iv). However, it is recommended that the Government should consider keeping both the physical and financial stocks in line with ECOWAS policy to optimize the use of resources in stocking and management since the financial reserve allows for flexibility in operational activities in times of emergency.

v). The Warehouse Receipt System is a practical model for linking small agricultural producers to the FSRD/NFRA. It is necessary to fast-track the enabling instrument for operating and implementing the Warehouse Receipt System.

vi). Re-introduction of the Bill for Commodity Exchanges where the Food and Reserve Value Chain will be a beneficiary from the Capital Market for transparency and funding.

vii). The government should improve the functionality of Market Information Systems especially the informal grain market indices including registration/monitoring of private sector held stocks, and transparent market regulation is recommended in Nigeria for effective price stabilization. Digital tools can be applied to provide a real-time online tracking system for stocks and linked to the food balance sheet to trigger stocking and destocking.

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11 Annexures

Annex 1: Cost Estimates to Equip the Facilities with New Technical Components for Silos located at Dustinma, Minna, Ilesha, Gusau, Yola and Irrua

S/No	New Technological Component	Qty	Rate (₦)	Amount (₦)	Amount USD ($)	Remark
1	Supply and installation of Carbon sensors Capable of measuring 0 to 5000 ppm using infrared gas sensor	6 x 10	150,000	9,000,000	21,454	For faster detection of the onset of grains deterioration in the six silo complexes managed by FGN
2	Supply and installation of grain spreader that is self-adjusting with ability to handle 50 tons per hour for a bin diameter of 18 metre.	6 x 10	200,000	120,000,000	286,055	Provision for each of the six silo complexes managed by FGN
	Total			**129,000,000**	**307,509**	

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 2: Dutsinma Silo, Cost of Repairs/Rehabilitation of Faulty Components

S/No	Component	Qty	Rate (₦)	Amount (₦)	Amount USD $
1	Replacement of elevator buckets HDPE cups for 50 tons/hr elevator 200mm x 150 nominal size	400	5,000.00	2,000,000.00	4,767.58
2	Replacement of aeration fans 15kw, 18 m3/hr at 225mm swg. 3ph, 380/420V 50hz		3,000,000.00	15,000,000.00	35,756.85
3	Dry intake pit20 metres long drag chain conveyor of 50 tons per hour. Conveyor casing width is 280mm	20m	100,000.00	2,000,000.00	4,767.58
	Complete chain conveyor of 50 tons per hour operating at 0.6m/sec and 20 metres long with a drive head using 380 volts, 50 hz	20m		6,000,000.00	14,302.74
4	Wet intake pit,	20m	100,000.00	2,000.00	4.77
	20 metres long drag chain conveyor of 50 tons per hour. Conveyor casing width is 280mm				0.00
	Complete chain conveyor of 50 tons per hour operating at 0.6m/sec and 20 metres long with a drive head using 380 volts, 50 hz	20m		6,000,000.00	14,302.74
5	Industrial bag sewing machines. Bag closing machine of 4 stiches per inch and runs at 35 feet per minute, 220 volts, 50 Hz	2	8,500,000.00	17,000,000.00	40,524.43
6	Leaking chutes.Supply and replace leaking chutes, elbows, diverters, and any other leaking fittings from 100mm to a maximum of 200mm diameter	L/S	2,000,000.00	2,000,000.00	4,767.58
	Total			**50,002,000.00**	**119,194.28**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 3: Minna Silo Complex, Cost of Repairs/Rehabilitation of Faulty Components

S/No	New Technological Component	Qty	Rate (₦)	Amount (₦)	Amount USD $
1	Replacement of set of sieves for grain cleaner	1	2,000,000	2,000,000	4,767.58
2	Replacement of elevator buckets HDPE Plastic cups 200 x 150mm	400	5,000	2,000,000	4,767.58
3	Replacement of aeration FAN 15kw, 18m3/hr at 225mm swg, 3 Ph, 380V, 50 Hz	5	3,000,000	15,000,000	35,756.85
4	Rehabilitation of leaking roofs (Lump Sum)	1	2,000,000	2,000,000	4,767.58
5	Industrial sewing machines. Bag closing machine of 4 stiches per inch and runs at 35 feet per minute, 220 volts, 50 Hz	2	8,500,000	17,000,000	40,524.43
6	Complete set of temperature cables,	10	3,000,000	30,000,000	71,513.71
7	Handheld monitor	1	500,000	500,000	1,191.90
8	Integrated computer Program	1	200,000	200,000	476.76
			Total	**68,700,000**	**163,766.39**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 4: Ilesa Silo Complex, Cost of Repairs/Rehabilitation of Faulty Components

S/No	Component	Qty	Rate (₦)	Amount (₦)	Amount USD $
1	Comprehensive repairs of the gear switch, electrical faults and rewiring of the bagging machine. Including calibration (Lump Sum)	1	8,000,000	8,000,000	19,070
	Total			**8,000,000.00**	**19,070**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 5: Gusua Silo Complex, Cost of Repairs/Rehabilitation of Faulty Components

S/No	Component	Qty	Rate (₦)	Amount (₦)	Amount USD $
1	Replacement of set of sieves for grain cleaner	1	2,000,000	2,000,000	**4,767.58**
2	60-ton capacity bulk loading silo with hopper bottom made of corrugated steel and carried on a steel structure, including vertical ladder and roof ladder and roof vent.	1	12,700,000	12,700,000	**30,274.14**
	Total			**14,700,000**	**30,274.14**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 6: Yola Silo Complex, Cost of Repairs/Rehabilitation of Faulty Components

S/No	Component	Qty	Rate (₦)	Amount (₦)	Amount USD $
1	Repairs of the control Panel	1	4,000,000	4,000,000	9,535.16
2	Supply of elevation cups HDPE plastic elevator cups of 200mm x 150mm	400	5000	2,000,000	4,767.58
3	Replacement of conveyor 1 and 2 40 metres long grains chain conveyor of 50 tons per hour capacity Casing width 280mm wide.	80	100,000	8,000,000	19,070.32
	Complete chain conveyor of 50 tons per hour operating at 0.6m/sec and 40 metres long with a drive head using 380 volts, 50 hz	2	7,000,000	14,000,000	33,373.06
4	Replacement of Temperature probe Set of temperature cables of 10 per silo	10	3,000,000	30,000,000	71,513.71
	Handheld Monitor		500,000	0	0.00
	Integrated advanced computer program PC		200,000	0	0.00
5	Faulty fuses:			0	0.00
	i. 6No 400amp	6	50,000	300,000	715.14
	ii. 10No 10amp	10	11000	110,000	262.22
	iii. 10No 1amp	10	1000	10,000	23.84
	iv. 10No 6amp	10	11000	110,000	262.22
			Total	**58,530,000**	**72,777.12**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 7: Irrua Silo Complex, Cost of Repairs/Rehabilitation of Faulty Component

S/No	Component	Qty	Rate (₦)	Amount (₦)	Amount USD $	Remark
1	Replacement with a digital Control Panel. Lump Sum	1	5,000,000	5,000,000	11,918.95	To repair existing control panel and other electrical parts for the equipment is recommended. However, to change Irrua panel to digital may cost up to 18,000,000
2	Rehabilitation of the leaking roof of bins	9	2,000,000	18,000,000	42,908.22	
3	Replacement of faulty Discharge augers	9	3,000,000	27,000,000	64,362.34	
4	TEMPERATURE monitor Set of temperature cables of 10 per silo and 10 silo/site	10	3,000,000	30,000,000	71,513.71	
	Handheld Monitor	1	500,000	500,000	1,191.90	
	Integrated advanced computer program PC	1	200,000	200,000	476.76	
	Total			**80,700,000**	**192,371.87**	

Source: Equipment manufacturer representative (Unofficial), 2022

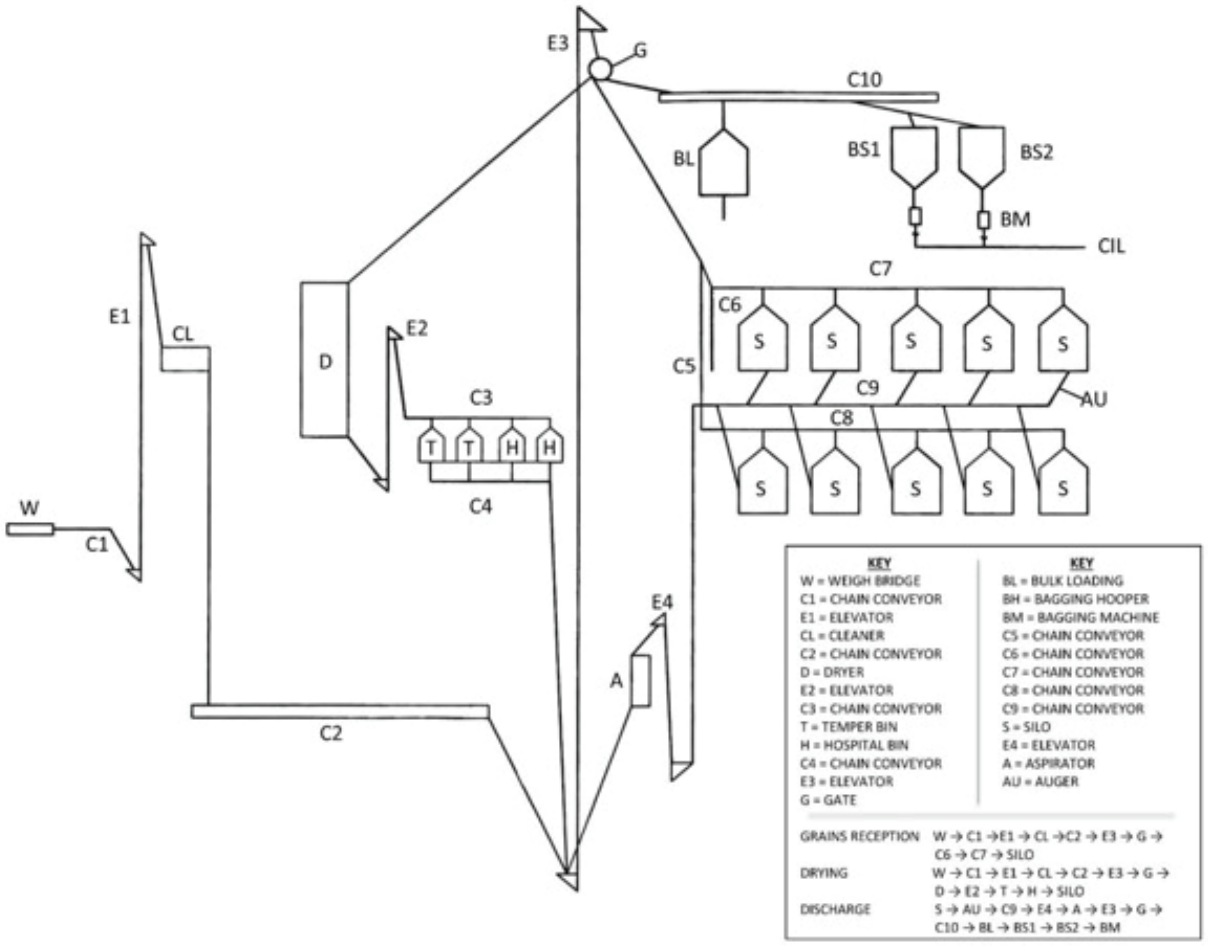
Annex 8: Summary of Cost Estimates for Repairs/Rehabilitation of Faulty Components of the Silo Complexes

S/No	New Technological Component	Amount (₦)	Amount USD $
1	Cost of Installing New Technological Components in all silos	129,000,000	307,508.94
2	Dutsinma Silo Complex	50,002,000	119,194.28
3	Minna Silo Complex	68,700,000	163,766.39
4	Ilesa Silo Complex	8,000,000	19,070.32
5	Gusau Silo Complex	14,700,000	30,274.14
6	Yola Silo Complex	58,530,000	72,777.12
7	Irrua Silo Complex	80,700,000.00	192,371.87
	Total	**409,632,000.00**	**904,963.05**

Source: Equipment manufacturer representative (Unofficial), 2022

Annex 9: Silo Complex Layout

The typical SGR Silo System flow chart below, gives an insight into the main key components of the silo complexes.



Rusty Inner Wall in a Silo Bin in Minna

Source: Yoeb Consultants Ltd.

Annex 10: Some Components in State of Disrepair-Dutsinma Silo

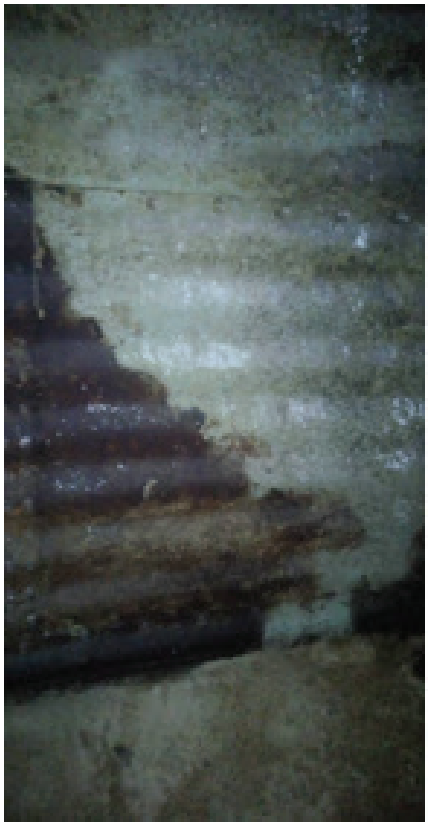
Conveyor chain breaking frequently

Patched elevator conveyor due to aging

Broken chain conveyor

Obsolete chutes at the central elevator pit

Annex 11: Some Components in State of Disrepair -Minna Silo



Annex 12: Some Components in State of Disrepair-Gusau Silo

Poor Performance of the Aspirator Showing Accumulation of Grain Dust at Gusau Silo

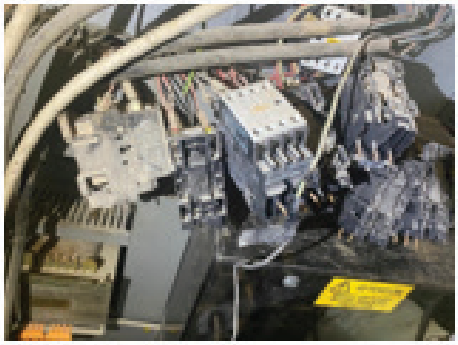
Rusty Inner Wall of the at Irrua Silo

Pinhole Opening Circled in Red in one Silo Bins, Irrua which permit water leakage into stock

Annex 13: Some Component in a State of Disrepair-Yola Silo

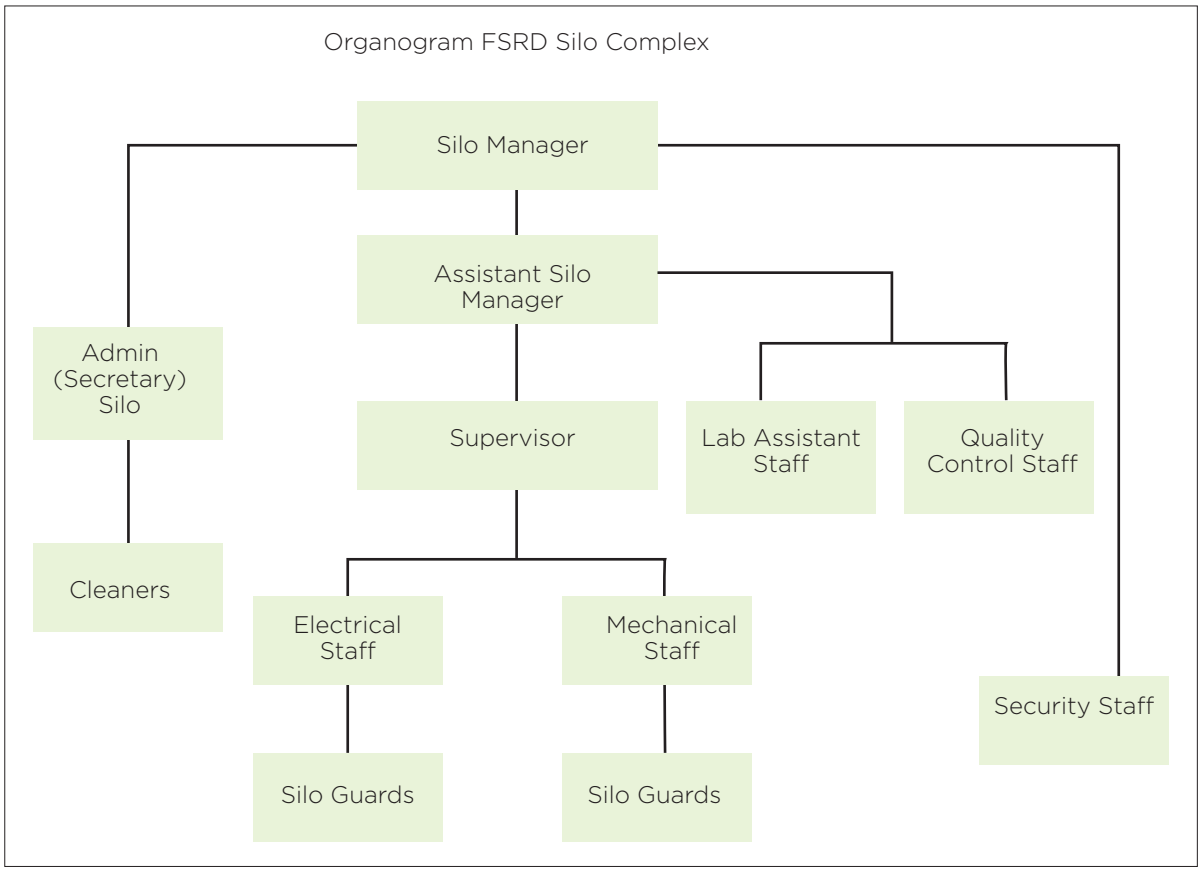
Chute connecting the Cleaner to teh Central Elevator patched so many times to manage its usage

Weak Intake Pit Chain Conveyor failing frequently in operation



Contractors for the automated areation system faulty and in state of disuse

Annex 14: Organogram FSRD Silo Complex



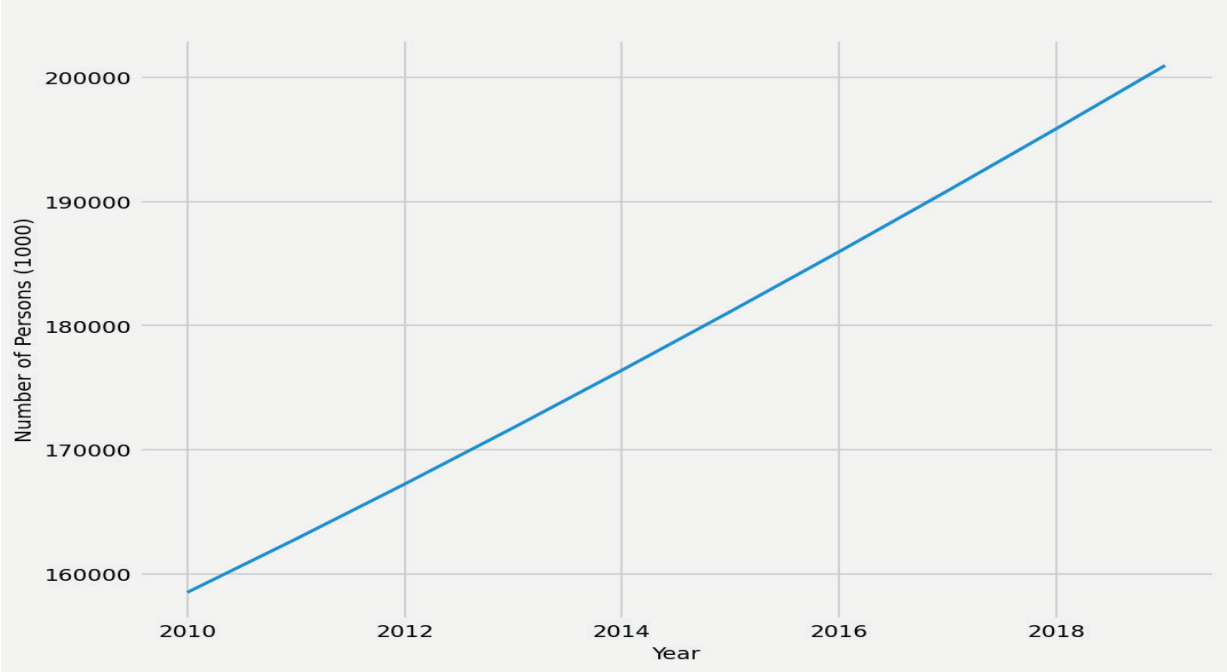
Annex 15: Detailed but Simplified Skill Gap and Capacity Building for FSRD

S/NO	Question	CAN Response/ Actual	% of Response/ Intended	Recommendation/Gap
1.	**Quality of human capital** Human capital constraint; critical positions not filled, due to lack of employment	Low No employment to fill vacant positions	56	
1.1	Retaining and managing human capital are also constrained	Low	22	
2.0	**Research Policy and Linkages.** FSRD has strong linkages with Ministries (62.5%), the legislators (50%) and the Private Sector (62.5%)	high	50-63	The Policy Making Capacity should be strengthened to address all policy matters.
2.1	The linkage is low with farmer association. (12.5%), NGOs/CSOs 37.5%	Low	13 -38	
2.2	Other policy matter: policy briefs and reports, source of research data	Low	13	
3.0	**Evidence Base Policymaking.** FSR advisor to FGN	Average	57	
3.1	Respond to request to provide advice on FSR related matters issues	High	71	
3.2	Involvement in producing strategy document in the last 2-5 years	Low	42	
3.3	**Policy Making Capacity** Major parliamentary committees: Senate and House Committees on Agric. FSRD participation	Low	13	
3.4	Research and Analytical product used 2017-2022	Low	25	
4.0	**Statistics, Monitoring and Evaluation**			
4.1	FSRD having full functional M & E System.	Very low	20	
4.2	FSRD periodically produce M&E for learning and redefining programme	High	60 - 80	
4.3	Adequate capacity for data processing and analysis	Yes	60	
4.4	Capacity for reporting and sharing	Low	40	
5.0	**Constraints and solutions**			
5.1	Research, Strategic Policy Analysis and Investment Planning	Low	17	Require employment of qualified researchers, training and development of business model
5.2	Programme management, M&E	Low	17	Employing qualified staff, training, staff welfare and provision of adequate fund. Silo operatives should be involved in decision making
5.3	Knowledge management and information sharing	Low	17	Capacity building/ Training
5.4	Leadership and management	Low	17	Provision of adequate physical and financial resources 2Management Training,

S/NO	Question	CAN Response/ Actual	% of Response/ Intended	Recommendation/Gap
5.5	Governance, organization, and institutional development	Low	17	
6.0	**Capacity to Act and Commit- Level of Effective Leadership in SGR Development Process**			
6.1	Is the political leadership, responsive, inspiring and sensitive	Low	33	The political leadership should pay more attention to Food Security Policies
6.2	What extent does FSRD provide strategic direction	Low	44	Involve all categories of staff in policy formulation
6.3	Staff turnover	Low	22	Improve on training and staff welfare
6.4	Staff Skill	Low	33	Organisation of trainings and workshops in the relevant area
6.5	Appropriate incentives	Low	22	Provision of awards to outstanding staff Improve organizational reward system to motivate staff
6.6	Adequate funding	Low	33	Provision of adequate funding and as at when due for smooth operation
7.0	**Capacity to adapt, learn and self-renew**			
7.1	Activities, outputs, outcomes are effectively assessed though M & E	Low	38	Appointment of M & E expert, capacity building/ training
7.2	Sector Reviews to effectively assess the effects of delivered products and services for future strategy	Low	38	Continuous staff engagement s and workshops through information dissemination, seminar, meeting more frequently
7.3	Internal Management and evaluation that results in learning from mistakes. Are members/staff comfortable to raise issues that reflects poorly on th government	Low	38	Involve staff in policy formulation
7.4	Are members/staff free to come up with ideas for implementation	Low	38	Members/staff should be encouraged to come up with ideas to further the project
7.5	Does FSRD have effective system to keep abreast with development in Food and Agricultural Sector	Low	38	Provision of feedback mechanism; increased use of internet facilities;
7.6	Openness and responsive to stakeholders and the public	High	63	Continuous stakeholders' engagements
8.0	**Capacity to deliver on mandate and developmental Objectives**			
8.1	Clear operational Pan	Average	57	Regular and adequate funding required; members/staff must understand the FSRD Mission and Vision and their individual roles
8.2	Extent of delivery of Planned outputs	High	86	Motivation and more capacity development

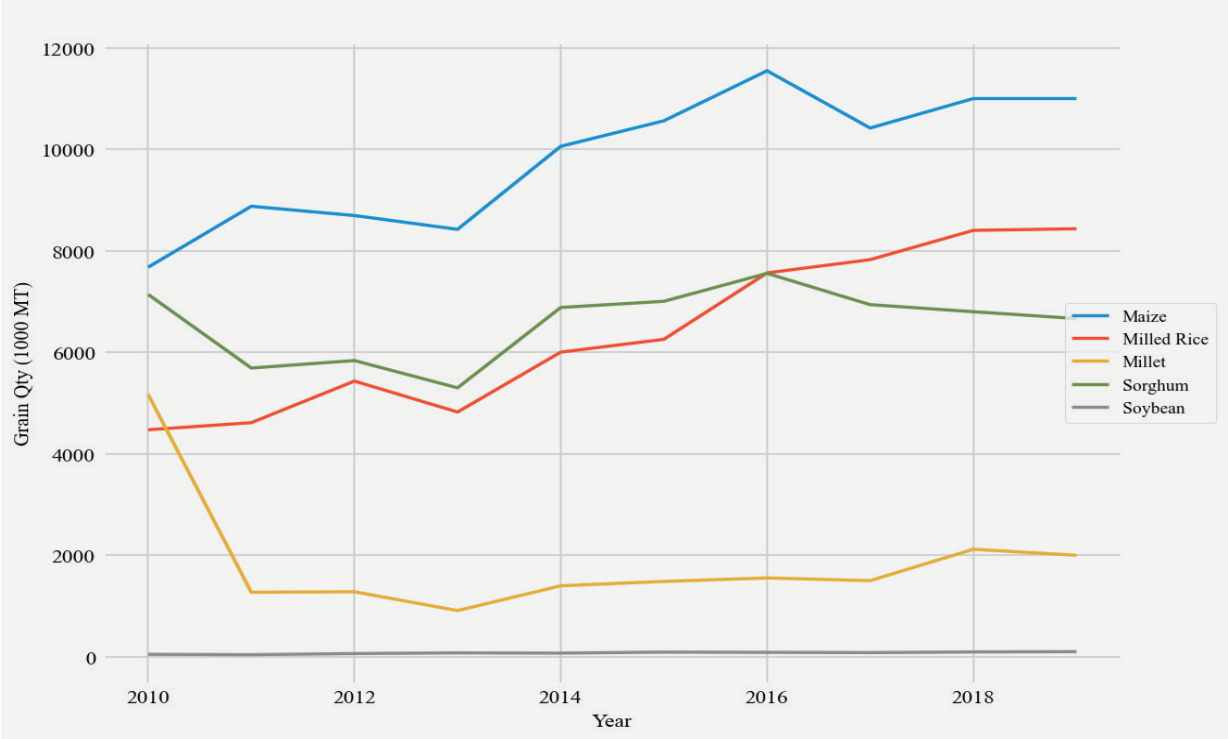
S/NO	Question	CAN Response/ Actual	% of Response/ Intended	Recommendation/Gap
8.3	Mechanism to verify services	High	71	Holding interactive sessions; review of feedback to address gray
9.0	**Capability to Coordinate and relate in alliances and Collaborative Efforts**			
9.1	Effective Coordination with partners and stakeholders	Low	40	Strengthen the coordination of external group
9.2	Maintains Relationships with existing network/alliances/partnerships	Low	40	Regular review of Strategic Plan with the Vision and Mission in View
9.3	Vision, Mission, and strategies are regularly discussed in FSRD	Average	50	All staff should be conversant with the Vision and Mission, and general operating guidelines.

Annex 16: Nigeria Population (2010 – 2019)



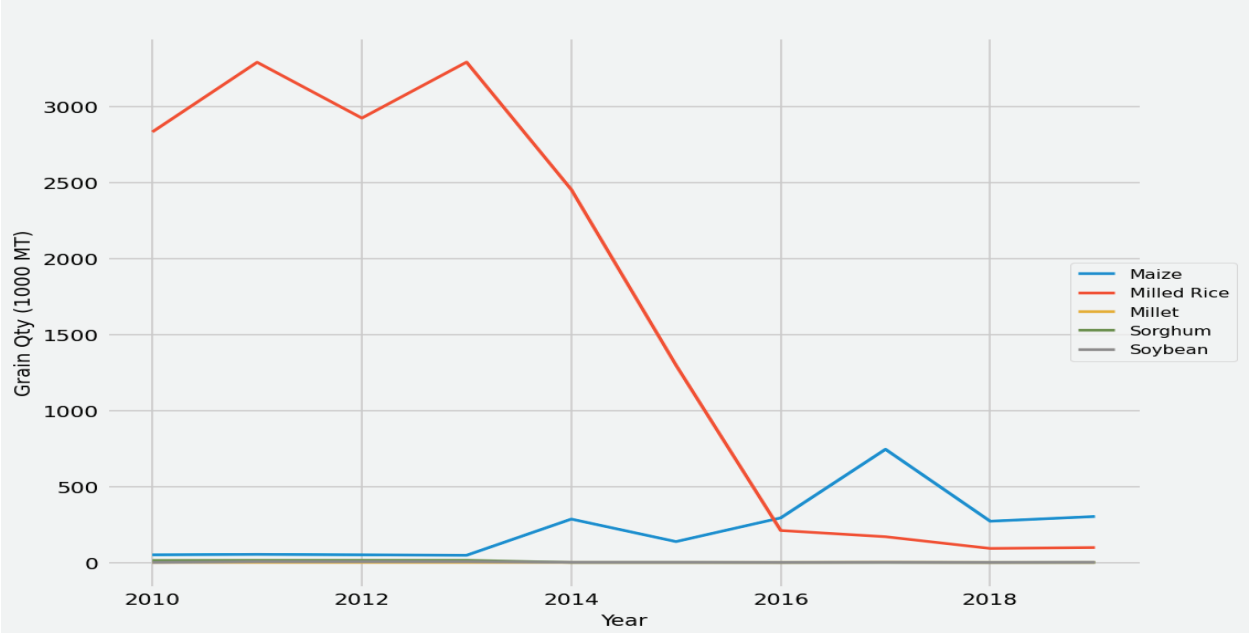
Source: FAOSTAT Data

Annex 17: Grains Production (2010 – 2019)



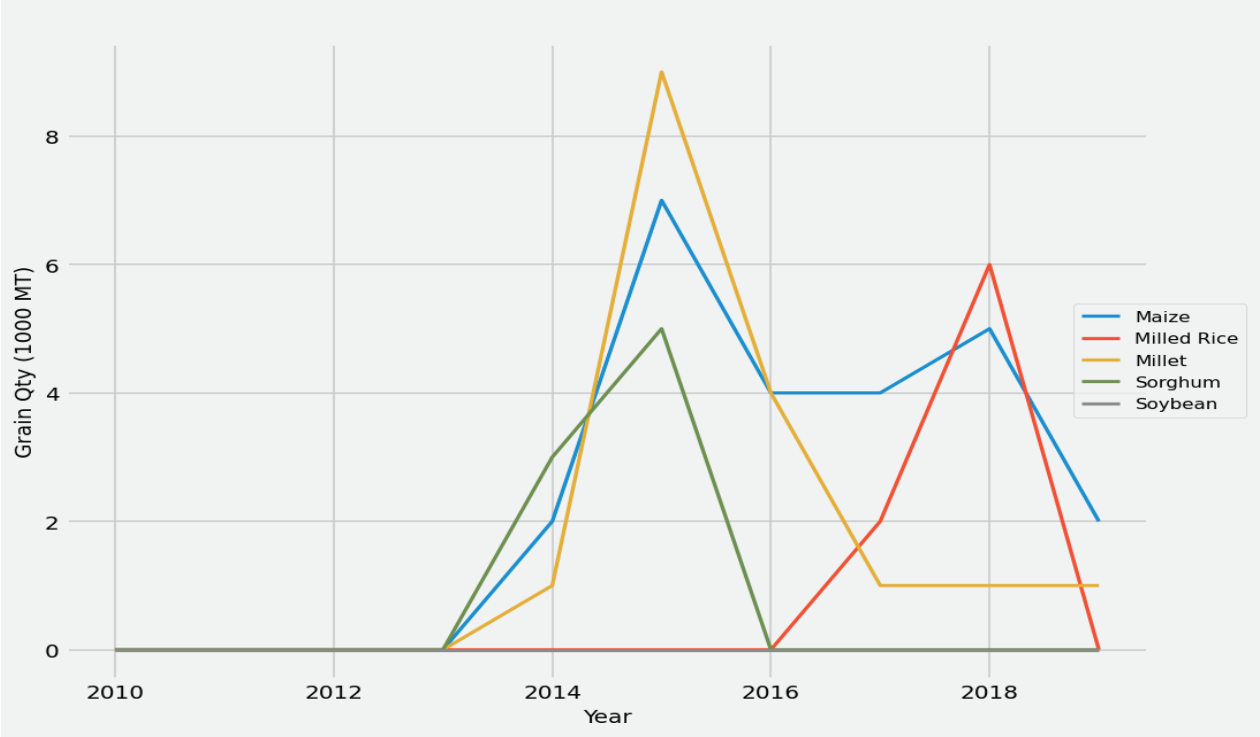
Source: FAOSTAT Data

Annex 18: Grains Imports (2010 – 2019)



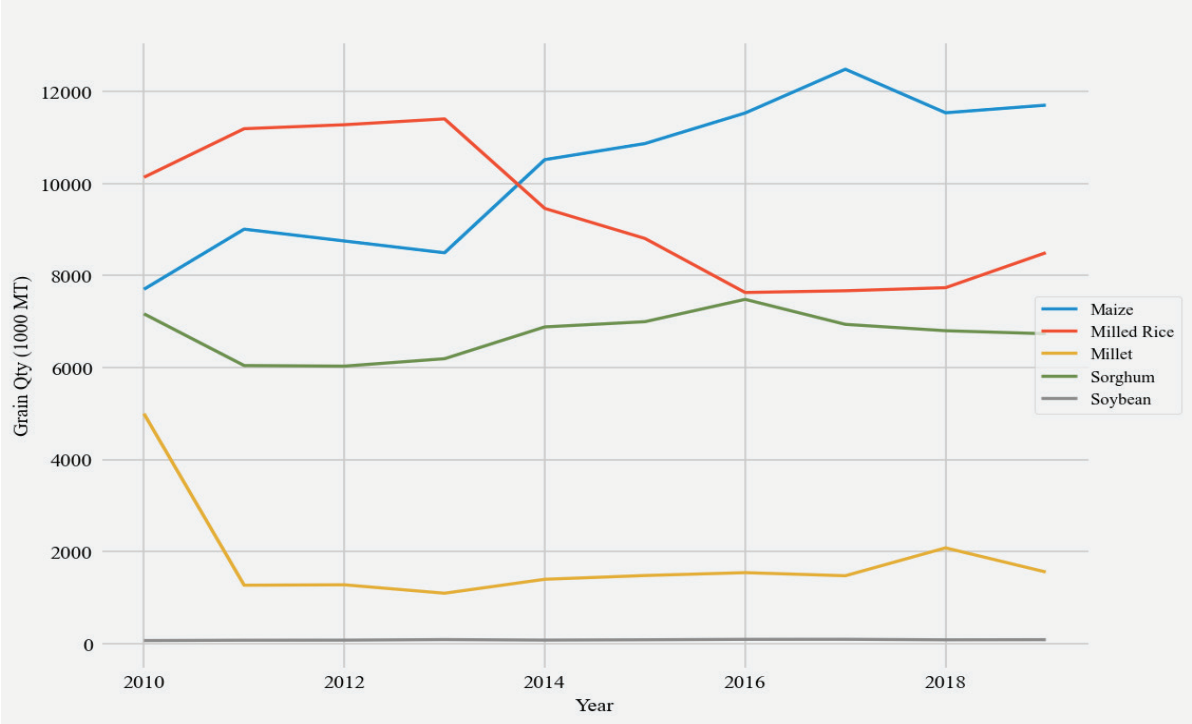
Source: FAOSTAT Data

Annex 19: Grains Exports (2010 – 2019)



Source: FAOSTAT Data

Annex 20: Grains Domestic Supply Plus Import (2010 – 2019)



Source: FAOSTAT Data

Annex 21: Optimal stock levels of the grains for stabilization reserve (95% Target Level of Consumption)

Year	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Total (1000MT)
2010	382.65	490.11	548.78	602.80	81.21	2,105.54
2011	399.23	633.09	575.49	816.30	71.16	2,495.29
2012	461.69	708.86	141.48	647.30	100.07	2,059.40
2013	459.98	760.10	142.59	667.13	114.40	2,144.19
2014	443.23	698.92	101.30	605.22	99.58	1,948.25
2015	520.51	801.71	155.73	781.95	150.90	2,410.80
2016	549.27	788.41	165.30	801.78	124.93	2,429.68
2017	623.94	913.82	172.87	860.23	152.98	2,723.84
2018	547.08	864.71	166.97	788.41	185.56	2,552.73
2019	587.65	867.80	235.87	763.27	202.22	2,656.81
2020	579.84	908.98	222.63	762.58	236.27	2,710.30
2021	533.04	962.35	222.63	751.63	221.82	2,691.47

Source: Author, 2022

Annex 22: Economy of Production (EOP) and Computation of Earning by the Farmer

State		2019				
	EOP (₦)		154,540			
		Price (₦)	Total (₦)	Gain (₦)	Earning/ Day (₦)	Earnings/ Day ($[6])
Abia		212,180.06	742,630.20	588,090.20	1,611.21	5.282643
Cross River		229,944.35	804,805.22	650,265.22	1,781.55	5.841143
Adamawa	Yield/Ha (3.5 MT)	88,885.53	311,099.36	156,559.36	428.93	1.406327
Niger		101,092.82	353,824.86	199,284.86	545.99	1.790118
Ondo		149,545.39	523,408.88	368,868.88	1,010.60	3.313442
Kaduna		97,669.04	341,841.65	187,301.65	513.16	1.682476
State		**2020**				
	EOP (₦)		**211,032**			
		Price (₦)	**Total (₦)**	**Gain (₦)**	**Earning/ Day (₦)**	**Earnings/ Day ($[7])**
Abia		263,428.51	921,999.79	710,967.79	1,947.86	**5.395726**
Cross River		241,921.05	846,723.67	635,691.67	1,741.62	**4.824435**
Adamawa	**Yield/Ha (3.5 MT)**	120,842.90	422,950.14	211,918.14	580.60	**1.608304**
Niger		161,550.36	565,426.26	354,394.26	970.94	**2.689593**
Ondo		189,503.16	663,261.04	452,229.04	1,238.98	**3.432088**
Kaduna		115,864.64	405,526.25	194,494.25	532.86	**1.476069**
State		**2021**				
	EOP (₦)		**230,823**			
		Price (₦)	**Total (₦)**	**Gain (₦)**	**Earning/ Day (₦)**	**Earnings/ Day ($[8])**
Abia		387,654.26	1,356,789.92	1,125,966.92	3,084.84	**7.524002**
Cross River		346,210.86	1,211,737.99	980,914.99	2,687.44	**6.554728**
Adamawa	**Yield/Ha (3.5 MT)**	144,563.34	505,971.71	275,148.71	753.83	**1.838615**
Niger		216,744.37	758,605.31	527,782.31	1,445.98	**3.526778**
Ondo		263,336.21	921,676.74	690,853.74	1,892.75	**4.616463**
Kaduna		183,824.62	643,386.18	412,563.18	1,130.31	**2.756854**

6 $1 = N305 in 2019
7 $1 = N361 in 2020
8 $1 = N410 in 2021

Annex 23: Optimal Stocks for Various Target Levels of Consumption – 2021 (consumptions estimated using equation 1 and optimal stocks estimated using equation 5 section 3.4)

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Sum Total (1000MT)
99%	186.63	669.11	550.48	91.54	31.84	1,529.60
98%	68.26	584.22	530.88	24.42	30.68	1,238.47
97%	0.00	499.33	511.29	0.00	29.52	1,040.14
96%	0.00	414.44	491.70	0.00	28.36	934.50
95%	0.00	329.55	472.10	0.00	27.20	828.85
94%	0.00	244.66	452.51	0.00	26.04	723.21
93%	0.00	159.77	432.92	0.00	24.88	617.57

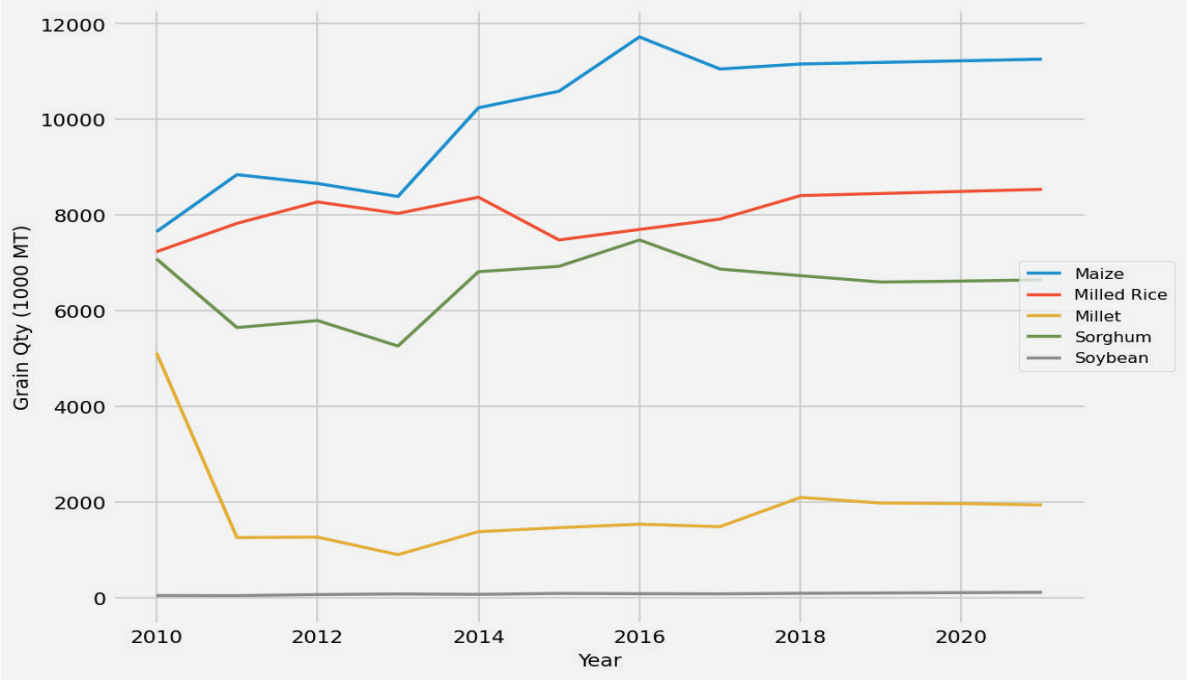
Source: Author, 2022

Annex 24: Optimal Capacities at different target levels of consumption - 2021 (consumptions estimated using equation 1 and optimal capacity estimated using equation 6 in section 3.4)

Target Level of Consumption	Maize (1000MT)	Milled Rice (1000MT)	Millet (1000MT)	Sorghum (1000MT)	Soybeans (1000MT)	Sum Total (1000MT)
99%	11,718.63	8,534.79	5,118.30	7,476.48	114.84	32,963.04
98%	11,600.26	8,448.58	5,066.60	7,400.96	113.68	32,630.08
97%	11,481.89	8,362.37	5,014.90	7,325.44	112.52	32,297.12
96%	11,363.52	8,276.16	4,963.20	7,249.92	111.36	31,964.16
95%	11,245.15	8,189.95	4,911.50	7,174.40	110.20	31,631.20
94%	11,126.78	8,103.74	4,859.80	7,098.88	109.04	31,298.24
93%	11,008.41	8,017.53	4,808.10	7,023.36	107.88	30,965.28

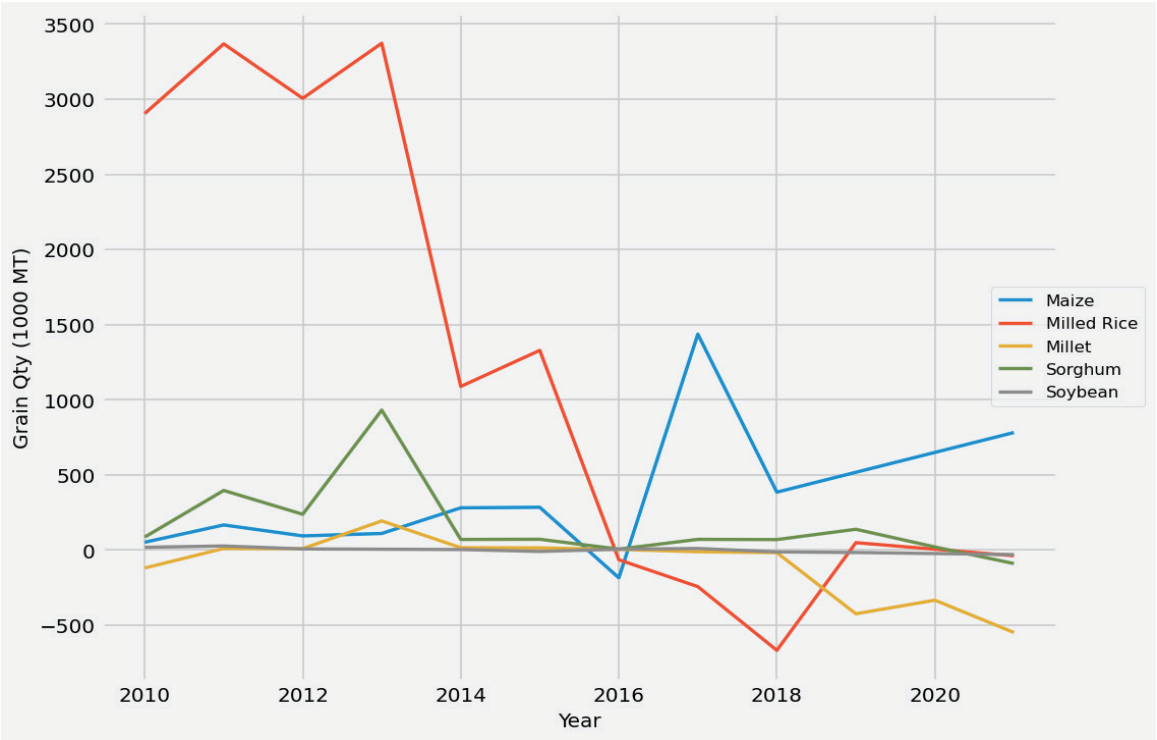
Source: Author, 2022

Annex 25: 99% Target Consumptions from 2010 – 2021 (consumptions estimated using equation 1 in section 3.4).



Source: Author, 2022

Annex 26: 99% Shortfalls from 2010 – 2021 (using equations 1 and 4 in section 3.4).



Source: Author, 2022

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